GE Healthcare

SIGNA pulse

THE MAGAZINE OF MR • AUTUMN 2010

INTERNATIONAL EDITION

Surprising strength

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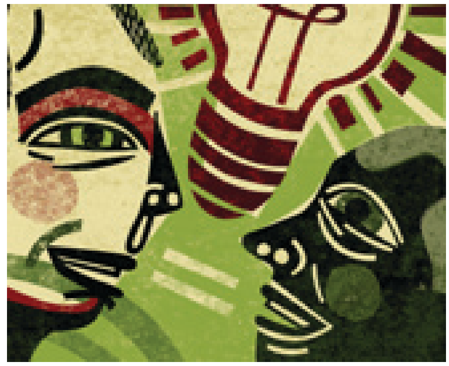

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GE Healthcare News

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Clinical Value

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*At the time of printing, the Optima MR430s system is not approved or cleared by the U.S. Food and Drug Administration (FDA) and is not available in the USA.

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Welcome

It is hard to believe that another year is drawing to a close. And what a year it has been! The world economy continued to recover from the depths of the financial crisis, slowly in the developed world and at a much faster pace in the developing world. Healthcare reform in the United States was signed into law in April 2010. It will affect all of us involved in the healthcare industry but the precise nature of its impact is still uncertain. The oil spill in the Gulf of Mexico dominated the news for many months, countries in Europe were affected by debt default concerns, and South Africa captivated the world in hosting the World Cup.

We at GE Healthcare have also been making news!

We like to think of the 3Ps—performance, patient comfort, and productivity. Our motto is "No Compromise." We design our systems so that you, whether you are a radiologist, a technologist, a patient, or an administrator, do not have to compromise.

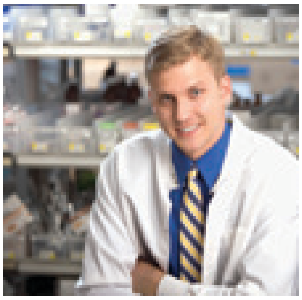
A great example of this was the **Optima MR450w** which we introduced in 2009. It is delivering on the promise of "wide bore done right." You can read profiles of three facilities that rave about the system's spectacular image quality, unparalleled field of view, exceptional patient throughput, and high level of patient comfort. When you think that 30% to 40% of patients have a difficult time because they feel confined and claustrophobic, you can see why we think it is a big deal!

I also wanted to take a few minutes to talk to you about **healthymagination**. This term has become a part of our daily lives. It's our theme for the 2010 Radiological Society of North America (RSNA) Annual Meeting. Healthymagination is all about achieving better healthcare for more people at a lower cost. So why are we doing it and how do we do it?

All over the world, governments are wrestling with **controlling costs**, **increasing access**, and **improving quality** in healthcare. Through GE's healthymagination technologies, innovation, and people, we are generating meaningful solutions to these global challenges. Products that we introduce are healthymagination validated by an external company called Oxford Analytica which certifies that the innovation passes certain hurdles of cost, quality, and access.

Here at MR we have taken healthymagination to heart. Throughout this magazine you will see this vision and examples of how we are delivering on the vision. Let me highlight two examples.

With the healthymagination validated **1.5T specialty scanner**, we can image extremities in an appropriately-sized scanner with no compromise in image quality. Compared to whole-body scanners, specialty scanners offer significantly greater patient comfort, significantly lower costs of ownership, and equivalent image quality to whole body 1.5T scanners. We've chosen to spotlight specialty scanners so that you can see how clinicians are pushing the boundaries of extremity imaging with these 1.5T systems.



James E. Davis

MR-Touch/MR Elastography: This healthymagination validated product launched in 2009 is now commercially available on even more platforms. In the clinical value section of this issue, you'll find several clinical cases from all over the world that show how MRE is being used in day-to-day clinical practice. In addition, in the Beyond the Scan section, you can read about the cost effectiveness of MRE. Any way you look at it, there is no doubt that MR-Touch represents a sound choice for radiologists, referring physicians, and radiology administrators.

A number of other applications are also highlighted to continue the theme of clinical leadership and performance.

Inhance Inflow IR provides consistent, high quality images of the renal arteries without contrast. **3D FSE-Cube on 3.0T** offer isotropic resolution for the entire joint in a single acquisition, thereby eliminating the need for repeat sequences and without impacting diagnostic performance compared to a routine MR imaging protocol.

3D ASL, a new perfusion imaging technique, has very high SNR and greater dynamic range than that of echo planar dynamic susceptibility contrast—thus offering inherent resistance to susceptibility artifacts. This sequence provides an option for patients who historically could not receive a perfusion study due to their renal status or poor IV access, such as the elderly or pediatric population.

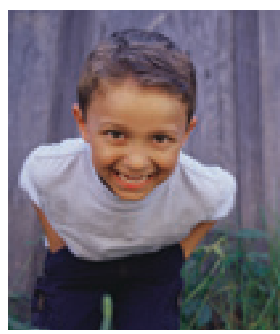
I could go on! We have a lot to share as our pipeline of products is stronger than it has ever been. Our people are working hard to bring you products that do not force you to choose between performance, patient comfort, and productivity. We believe you can have it all.

In closing, let me salute our **Thought Leaders** who apply their uncompromising vision to advancing the field of MR. Just as their work revolutionizes science today, so it will touch our lives tomorrow. We are honored that they have chosen to collaborate with us.

I look forward to seeing you at RSNA where we will preview even more exciting innovations.

James E. Davis

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



GE looks forward to seeing you at the following events in 2011.

Date	Conference	Site	City/State	Country	Web Link
Jan. 24–27	Arab Health 2011	Dubai International Exhibition Centre	Dubai	United Arab Emirates	www.arabhealthonline.com
Jan. 29–30	Society of Breast Imaging	The Fairmont, Turnberry Isle	Miami, FL	USA	www.sbi-online.org
Feb. 3–6	2011 SCMR/EuroCMR Joint Scientific Sessions	Nice Acropolis Convention Centre	Nice	France	www.scmreurocmr2011.org
Feb. 6–11	Vail 2011: New Advances in MR & CT	Vail Marriott Mountain Resort & Spa	Vail, CO	USA	www.educationalsymposia.com
Feb. 15–19	American Academy of Orthopaedic Surgeons (AAOS)	San Diego Convention Center	San Diego, CA	USA	www.aaos.org
March 2–4	American Society of Functional Neuroradiology (ASFNR)	Pointe Hilton Tapatio Cliffs Resort	Phoenix, AZ	USA	www.asfnr.org
March 3–7	European Congress of Radiology 2011 (ECR)	Austria Center Vienna	Vienna	Austria	www.myesr.org
April 2–5	American College of Cardiology (ACC) 60th Annual Scientific Sessions	Ernest N. Morial Convention Center	New Orleans, LA	USA	www.accscientificsession.org
April 3–6	The Breast Course	Renaissance Polat Hotel	Istanbul	Turkey	www.thebreastpractices.com
April 4–8	28th Annual Magnetic Resonance Imaging 2011: National Symposium	The Venetian	Las Vegas, NV	USA	www.educationalsymposia.com
April 5–7	Musculoskeletal/Orthopedics MRI 2011: National Symposium	The Venetian	Las Vegas, NV	USA	www.educationalsymposia.com
April 7–10	70th Annual Meeting of Japan Radiological Society	Pacifico Yokohama Convention Center	Yokohama	Japan	www.secretariat.ne.jp/jrs70/eng/index.html
April 9–13	American Association of Neurological Surgeons (AANS)	Colorado Convention Center	Denver, CO	USA	www.aans.org
April 28–May 1	41st Jornada Paulista de Radiologia—JPR 2011	Transamerica Expo Center	Sao Paulo	Brazil	www.spr.org.br
May 7–13	Joint Annual Meeting ISMRM-ESMRMB	Palais des Congres de Montreal	Montreal, Quebec	Canada	www.ismrm.org
May 27–31	6th Congress and Exhibition of the Joint Societies of Paediatric Radiology	Hilton London Metropole Hotel	London	UK	www.ipr2011.org

42,000 Year-Old Baby Mammoth Scanned

GE Healthcare got a close-up look at a 42,000 year-old baby woolly mammoth using state-of-the-art medical equipment. Discovered in 2007 by a reindeer herder in northwestern Siberia, Lyuba (pronounced Lee-OO-bah) is considered the best-preserved mammoth ever discovered.

Researchers wanted to collect data to learn more about the life and features of this extinct species. "A lot of the information Lyuba can provide is not visible on the surface, so to be able to see things through a CT or MR scan, which show her internal organs and the structure beneath her skin is really important," says Tom Swerski, Project Manager of Exhibitions of The Field Museum.

Lyuba was scanned on a high performance open MRI system, the Signa† OpenSpeed EXCITE 0.7T, to view her soft tissue including the brain, liver, and heart. Lyuba is currently on loan from Russia and will be on display in the United States in the exhibition "Mammoths and Mastodons: Titans of the Ice Age." ■

New MR Global Web Seminars: Learn From the Experts to Make the Most of Your Scanner

GE Healthcare is pleased to launch a new MR Applications Web Seminar Series

These live, free Web seminars feature clinical experts in different clinical areas and address topics important to your practice, including non-contrast imaging, body imaging, robust imaging under motion or susceptibility, and workflow. For example:

Inhance: Non-Contrast MRA Made Easy
Renal, peripherals & beyond

Learn how the Inhance Non-Contrast MRA techniques can change your practice and your management of patients with high NSF risk. The speaker will share his experience on the clinical applications of various non-contrast MRA techniques, their advantages and limitations, how to triage your patients, and the future outlook. He will also discuss his center's experience in referral pattern changes with the introduction of these techniques.

You can attend a live session or view archived sessions at no charge. Visit **www.gehealthcare.com/mr_webinars** to complete your online registration for this event and others, and provide input to help determine future topics. ■

Optima† MR430s: High-Field Strength, Extremity-Specific MR System*

Whole-body MR scanners can be effective at imaging extremities, but those systems are also in high demand for critical imaging of the brain, cardiovascular system, spine, and abdomen. Further, the whole-body MR experience can be stressful and uncomfortable for some patients, particularly when claustrophobic or asked to hold an extremity in a static position for a long time.

While smaller, extremity-only MR systems have been on the market for years, they have not been widely adopted because of their low field strength and resultant poor image quality.

In 2009, GE Healthcare expanded into the extremity-specific arena by purchasing certain assets of ONI Medical Systems. The two systems that became part of the GE Healthcare portfolio were the MSK Extreme 1.0T and the MSK Extreme 1.5T. The Optima MR430s* builds on the technology and comfort offered by the MSK Extreme 1.5T. The Optima MR430s features a 1.5T superconducting magnet, a 70/300 gradient subsystem and a set of transmit/receive RF coils. The Optima MR430s has passed the rigorous third-party assessment to be healthymagination validated. ■

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

High-Tech Breakthrough 3.0T MR Imaging Introduced to Romania

GE Healthcare and Signa+ Medical Imaging Center recently announced the installation of Romania's first 3.0T Magnetic Resonance (MR) Scanner. A first for Romanian medical services, 3.0T MR investigations are now available to patients in Bucharest at the new center for research and diagnostics in medical imaging at Signa+.

GE Healthcare's HDxt 3.0T MR is the one of the most sophisticated scanners available for clinical use, helping to provide clearer, more precise images that highlight previously undetectable details. Innovative features of the system help reduce exam set up and scanning times. Patients can spend less time in the scanner, doctors can get better images, and the overall patient experience can be improved.

A number of investigations which could previously only be done using Computed Tomography scanning can now be performed to the same qualitative standard using the HDxt 3.0T MR scanner, but without the need for the associated X-ray dose. This installation is in line with GE's healthymagination strategy aimed at improving access to healthcare technologies for more people worldwide. ■

MRE in Clinical Practice: Case Review Compendium

MR Elastography (MRE) is a non-invasive method for evaluating tissue elasticity utilizing special phase encoding sequences with an MR system. Previously, a physician used palpation, a subjective technique limited to tissue of interest close to the surface, to find and evaluate pathological changes in the targeted tissue. GE launched MR-Touch, its commercial implementation of MRE, in July 2009.

Initially, MRE was used in conjunction with biopsy and other techniques. As physicians become more experienced with MRE in the clinical setting, their confidence in the information obtained with MRE grows stronger. MRE is now routinely used in clinical practice for the evaluation of liver disease at several sites worldwide. The cases reviewed here are collected from sites across the world and illustrate the clinical value of MRE in the evaluation of liver tissue due to many liver diseases.

Sites contributing MRE cases

San Diego, CA
Baltimore, MD
Madison, WI
Yamanashi, Japan
Seoul, Korea
Compiègne, France
Singapore
St. Paul, MN

Sites currently using MRE

Scottsdale, AZ
San Diego, CA
Jacksonville, FL
Rochester, MN
Houston, TX
Cambridge, United Kingdom
New Delhi, India

Sites pending MRE implementation

Seongnam, Korea
San Bernardino, CA
Dallas, TX
Milwaukee, WI
Pittsburgh, PA
Paris, France
Hong Kong

Dr. Russell N. Low

Contributor: Russell N. Low, MD, Medical Director Sharp and Children's MRI Center, San Diego, CA

Case 1: A 55-year-old man with rising liver function tests; two years post liver transplantation. The patient had many MR exams that show mild Splenomegaly and a normal appearing liver.

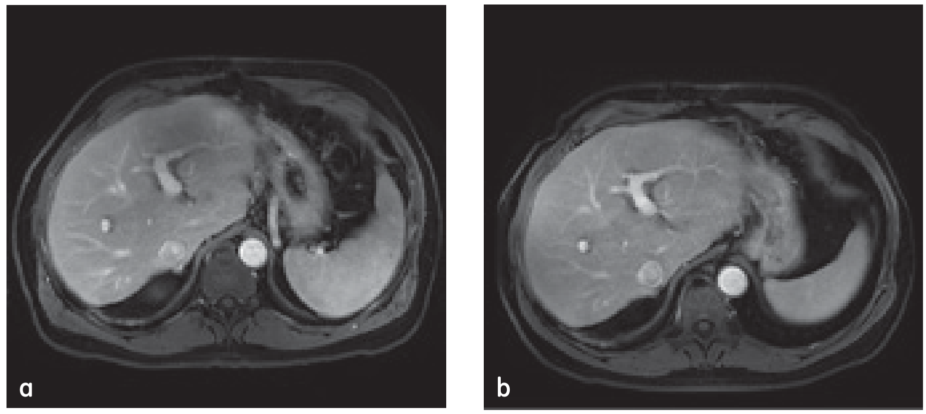


Figure 1. (a) MR image from December 2008, initial post-liver transplantation MR. (b) March 2009, liver biopsy shows mild fibrosis.

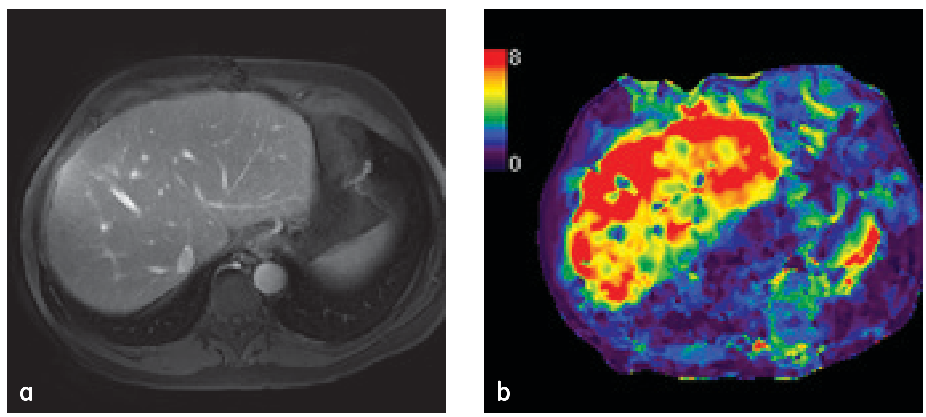


Figure 2. (a) MR image from December 2009, (b) MRE at this time shows stiffness levels consistent with moderate to marked fibrosis.

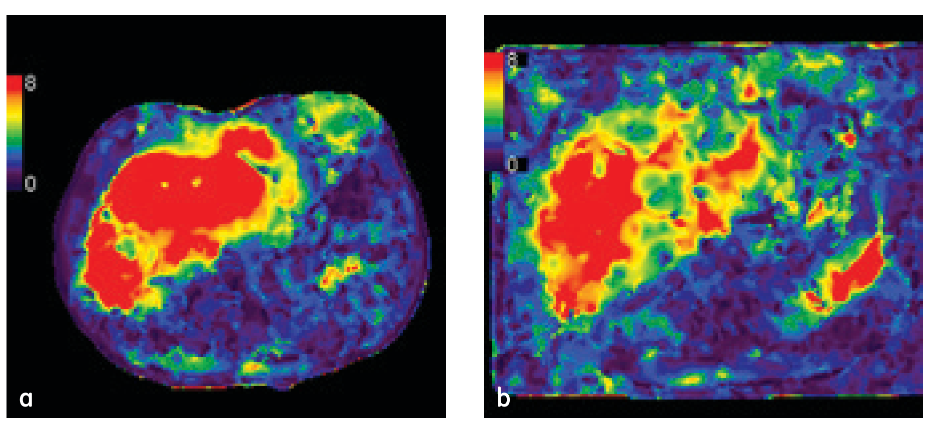


Figure 3. MRE images from March 2010, stiffness levels consistent with marked liver fibrosis. MRE on right suggests recurrent hepatitis C.

MRE Finding: The elastogram showed abnormal liver stiffness that is consistent with fibrosis from reinfection with hepatitis C. Results were confirmed by liver biopsy.

Contributor: Susanne Bonekamp, DVM, PhD, Research Associate in the Division of Clinical MRI, Department of Radiology, Johns Hopkins University School of Medicine, Baltimore, MD

Dr. Susanne Bonekamp

Case 1: A 50-year-old female patient with hepatitis C and HIV co-infection. Patient received biopsy 89 days after MRE (as part of a research study).

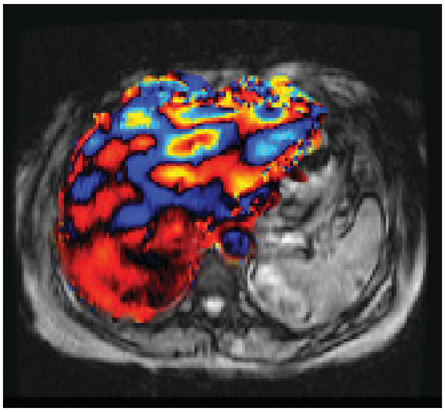


Figure 4a. MRI with color coded wave.

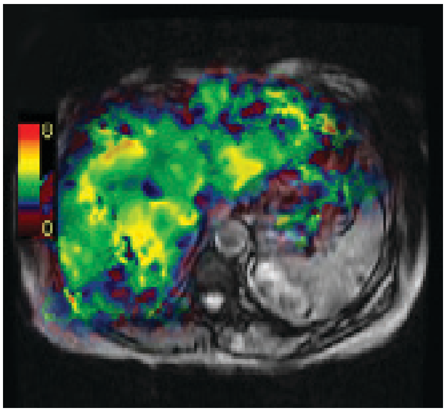


Figure 4b. MRI with elastogram.

MRE Finding: Elastogram is consistent with that of mild fibrosis. Biopsy showed steatosis, inflammation, and mild fibrosis (F1).

Case 2: A 47-year-old male patient with hepatitis C and HIV co-infection. Patient received biopsy 48 days after MRE (as part of a research study).

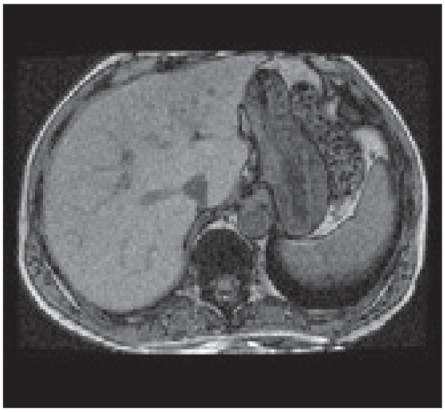


Figure 5a. MRI magnitude image.

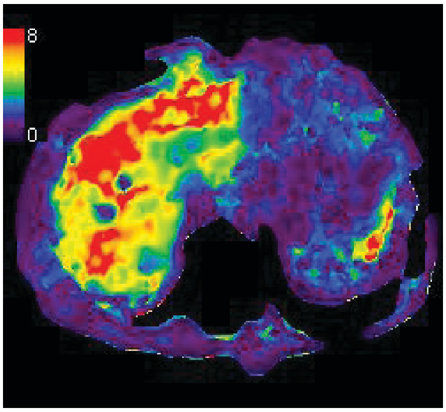


Figure 5b. MRI with elastogram.

MRE Finding: Elastogram shows stiffness consistent with that of severe fibrosis (METAVIR F4), 5–30% macrovascular fat, and mild necroinflammatory activity (overall MHAI=6).

Dr. Utaroh Motosugi

Contributor: Utaroh Motosugi, MD, PhD, Assistant Professor, Department of Radiology, University of Yamanashi, Yamanashi, Japan

Case 1: A 52-year-old female with clinically suspected primary biliary cirrhosis for seven years. Blood exam showed elevated ALP, anti-mitochondria antibody, and IgM.

Alkaline phosphatase (ALP): 712 IU/L (normal range: 100-248)
anti-mitochondria antibody: > 320 (normal range: < 20)
IgM: 311 mg/dL (normal range: 35-225)
Total bililbin: 0.6 mg/dL (normal range: 0.3-1.3)

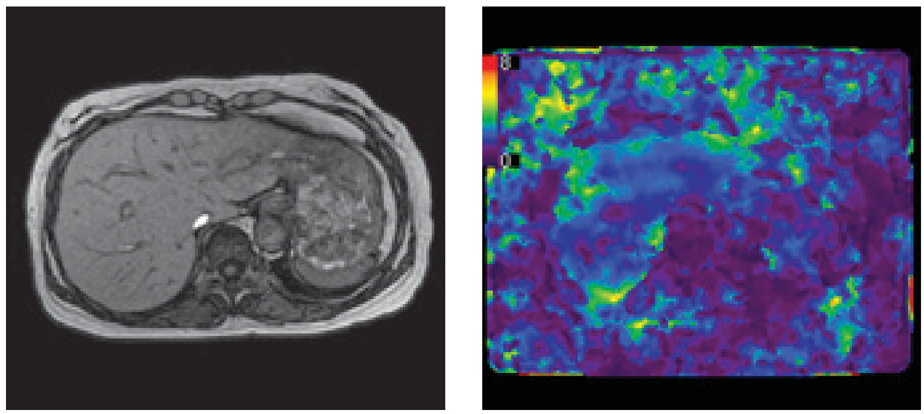


Figure 7.

MRE Finding: Based on the MRE, the mean stiffness for the region of interest did not indicate the onset of liver fibrosis. The planned biopsy to confirm liver fibrosis was deemed unnecessary and postponed.

Case 2: An 81-year-old male without history of liver disease: HBs-Ag (-), HCV-Ab (-), non-alcohol drinker, and no history of fatty liver disease.

Dynamic MRI using gadoxetic acid; Slight hypervascularity on arterial-phase image in the hepatic dome with subsequent hypointensity, suggesting hepatocellular carcinoma (HCC).

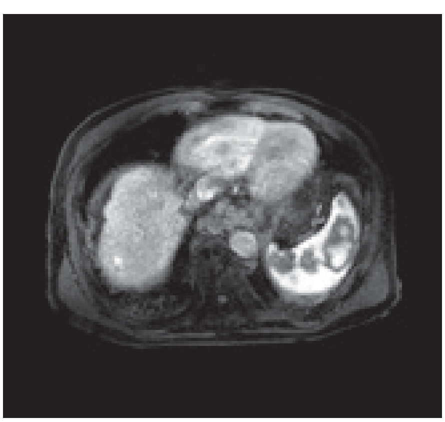


Figure 6a. Arterial-phase image of gadoxetic acid-enhanced MRI.

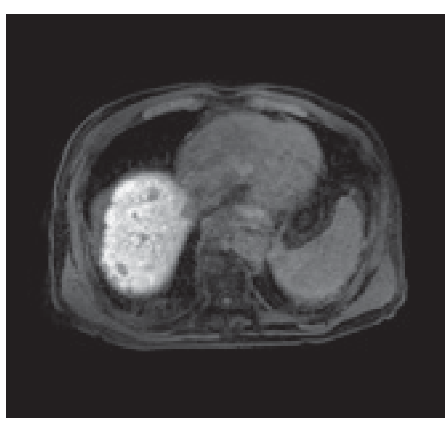


Figure 6b. Hepatocyte-phase after gadoxetic acid-administration.

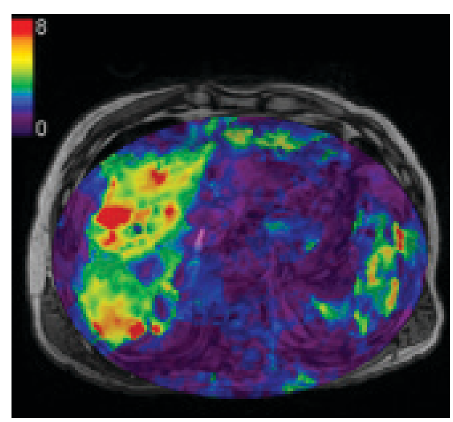


Figure 6c. MRE.

MRE Finding: MRE showed mean stiffness consistent with liver cirrhosis, which gave the radiologist more confidence in the diagnosis of HCC.

Contributor: Jeong Ming Lee, MD, Associate Professor, Seoul National University Hospital, Seoul, Korea

Dr. Jeong Ming Lee

Case 1: A 14-year-old with glycogen storage disease. Conventional MRI is not able to show definite changes of fibrosis.

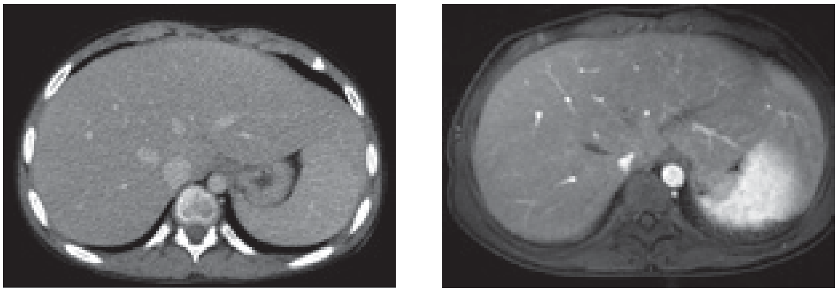


Figure 8.

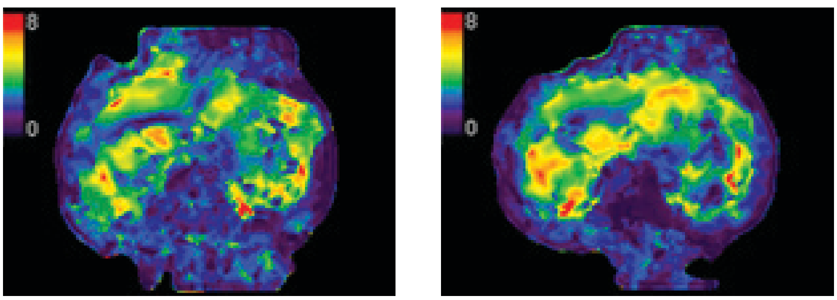


Figure 9.

MRE Finding: Elastogram indicates liver stiffness consistent with significant fibrosis. Pathology reveals F3 fibrosis.

Case 2: A 69-year-old male Hepatocellular carcinoma (HCC) with central necrosis.

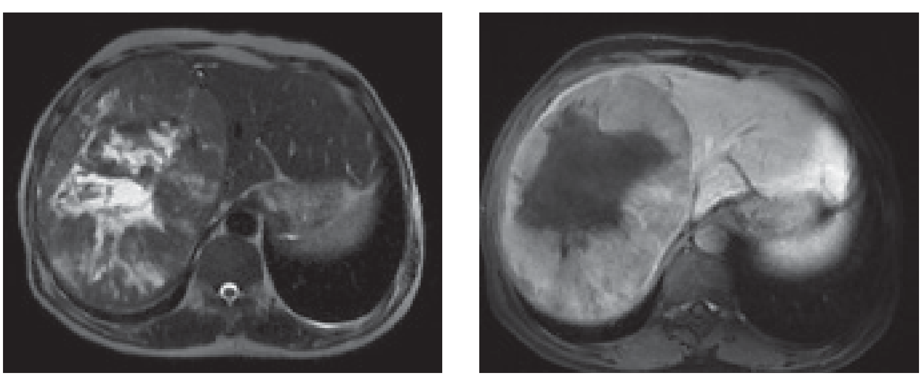


Figure 10.

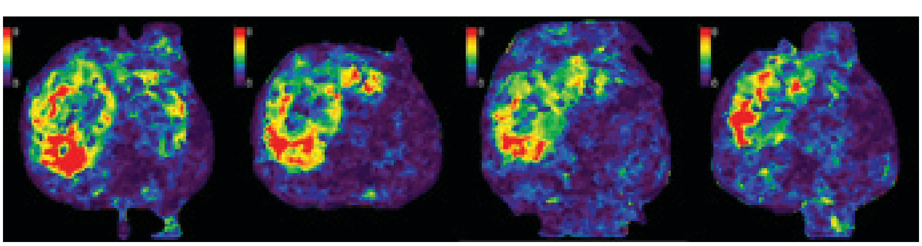
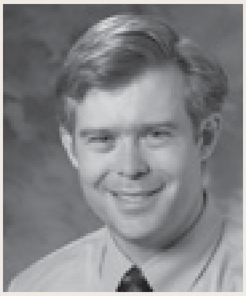


Figure 11.

MRE Finding: Elastogram shows elevated liver stiffness for the tumor and liver parenchyma, consistent with stage 1 fibrosis (F1). Pathology confirmed that this tumor was grade III HCC, and the liver showed no evidence of severe fibrosis.



Dr. Scott Reeder

**Contributor: Scott Reeder, MD, PhD,
Associate Professor, Section Chief of MRI, Department of Radiology, University of Wisconsin-Madison, Madison, WI**

Case 1: A 27-year-old male with increased ALT (241) and AST (79) and a BMI of 27kg/m^2

MRE Finding: The MRE stiffness is normal; chemical shift based imaging with T2* correction shows marked dropout of signal on the opposed phase image demonstrating the presence of severe steatosis; R2* map (=1/T2*) shows a normal T2* (27ms). The biopsy shows severe steatosis and no fibrosis or inflammation, and therefore the biopsy is concordant with MRE. In this case, MRE successfully differentiated (the tissue stiffness) between isolated steatosis and steatohepatitis.

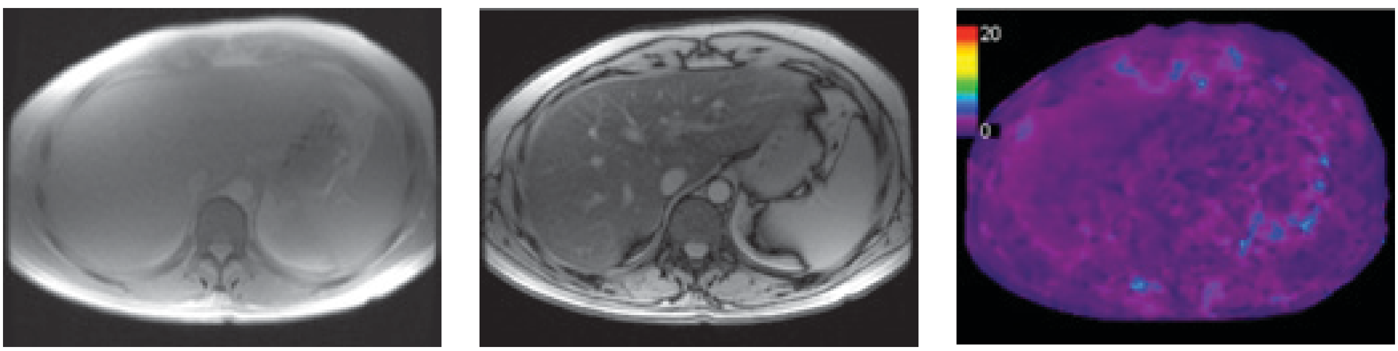


Figure 12. Marked dropout of signal on the opposed phase image demonstrates the presence of severe steatosis.

Case 2: A 10-year-old pediatric patient with abdominal pain.

MRE Finding: MRE study shows highly elevated stiffness. Chemical shift based imaging with T2* correction and long T2* (40ms) is consistent with steatosis and edema. Overall, the combined findings of MRE and chemical shift based imaging fit a clinical picture of acute steatohepatitis from non-alcoholic fatty liver disease. These findings were confirmed with biopsy that demonstrated severe steatohepatitis with severe bridging and pericellular fibrosis, most consistent with nonalcoholic fatty liver disease.

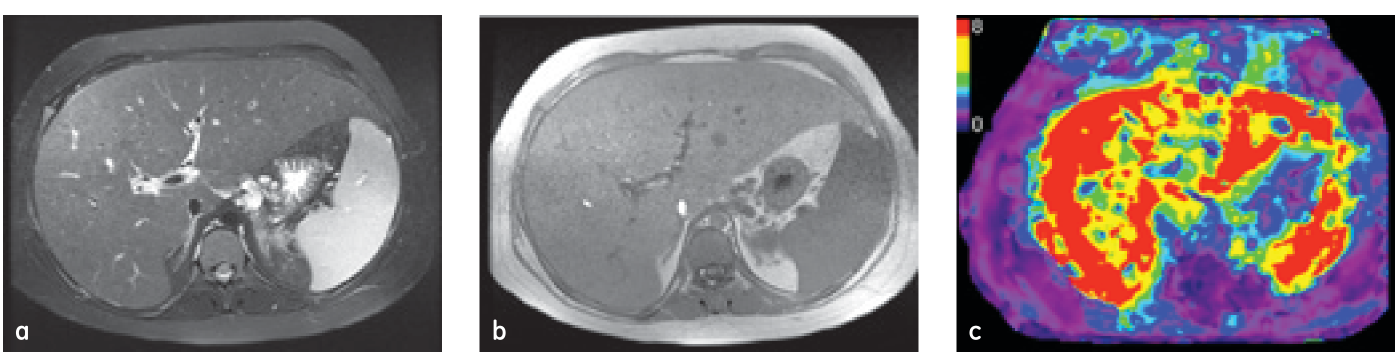


Figure 13. (a) T2 with fat sat, (b) in phase, (c) elastrogram

Contributors: Sabine F. Bensamoun, MD, PhD, Researcher CNRS in the Biomechanics and Bioengineering Laboratory at the University of Technology of Compiègne, Compiègne, France and Fabrice Charleux, MD, MRI radiologist, Department of Radiology, Polyclinic St. Côme, Compiègne, France

Dr. Sabine F. Bensamoun

Dr. Fabrice Charleux

Case 1: A 54-year-old, female, alcoholic. Fibroscan and Fibrometer revealed a liver fibrosis stage F4.

MRE Finding: The mean stiffness for the region of interest was consistent with that of stage F4 liver fibrosis, thus confirming the diagnosis. The patient was placed in detoxification therapy during three weeks.

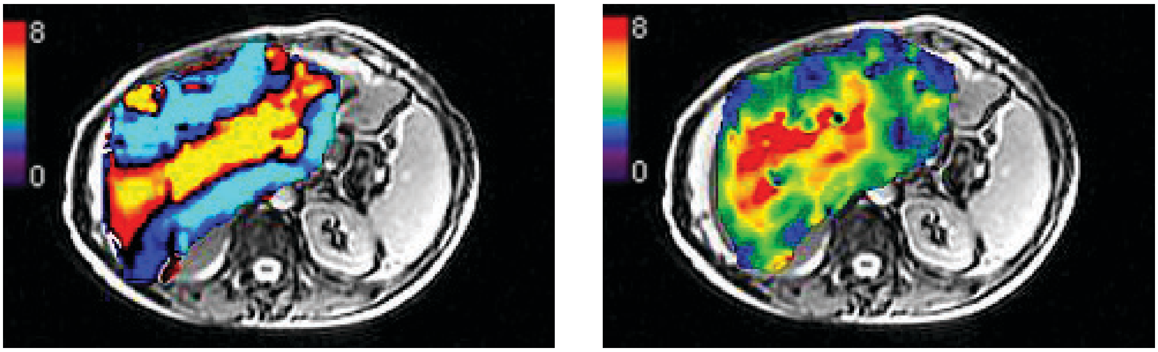


Figure 14.

Acknowledgement

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MRE in Clinical Practice: MRE Strengthens Practice Service Line

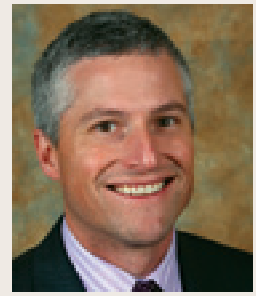
St. Paul Radiology, P.A. (SPR) is a large sub-specialized radiology group with an emphasis on abdominal imaging, including liver, pancreas, biliary mass characterization, CT and MR enterography for Crohn's disease and CT colonography. In the Fall of 2009, SPR introduced MRE to the hepatology community in the Minneapolis and St. Paul metropolitan area. The early introduction of MRE to the community practice is the result of a partnership between MRE's pioneer, Richard Ehman, MD, Mayo Clinic Rochester, and SPR's Peter Wold, MD, and Armen Kocherian, PhD.

Prior to MRE, only end stage hepatic fibrosis (i.e., cirrhosis) was detected via ultrasound, CT or MRI, Dr. Wold explains. "With MRE we can now detect subclinical hepatic fibrosis and help the hepatologist triage the patient appropriately, and this sets us apart from other practices in the area," he adds.

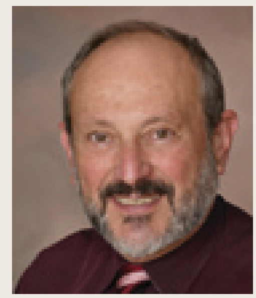
SPR's commitment to liver imaging caught the attention of Minnesota Gastroenterology, P.A. (MNGI), the area's largest provider of gastroenterology services. In Spring 2010, MNGI created a dedicated liver clinic that offers ultrasound-based HCC screening and asked SPR to provide professional services. MR elastography has gained gradual acceptance by MNGI's hepatologists as an effective non-invasive tool for evaluating hepatic fibrosis. According to Dr. Wold, "MRE has solidified our imaging practice's liver service line and has made a positive contribution to the care of patients with chronic liver disease. The continued referrals and increasing volumes indicate to me that MRE is helping the hepatologist treat their patients."

Coleman Smith, MD, FRACP, hepatologist with MNGI, agrees with Dr. Wold's assessment that an elastogram offers a prognosis of the patient's disease that helps him clarify patient management. "MRE also allows us to more carefully select the patients who should consider biopsy," he adds MRE is also useful to gain knowledge of a patient's fatty liver disease in situations where there is no other course of action—specifically patients who refused biopsy or have contraindications, Dr. Smith explains. "With MRE, we can determine if they have just fat in the liver or if fat has led to scarring or fibrosis, which can potentially lead to cirrhosis."

Contributors: Peter B. Wold, MD, Body Imaging Section, St. Paul Radiology, and Coleman Smith, MD, Hepatology Section Head, Minnesota Gastroenterology, P.A., St. Paul, MN



Dr. Peter B. Wold

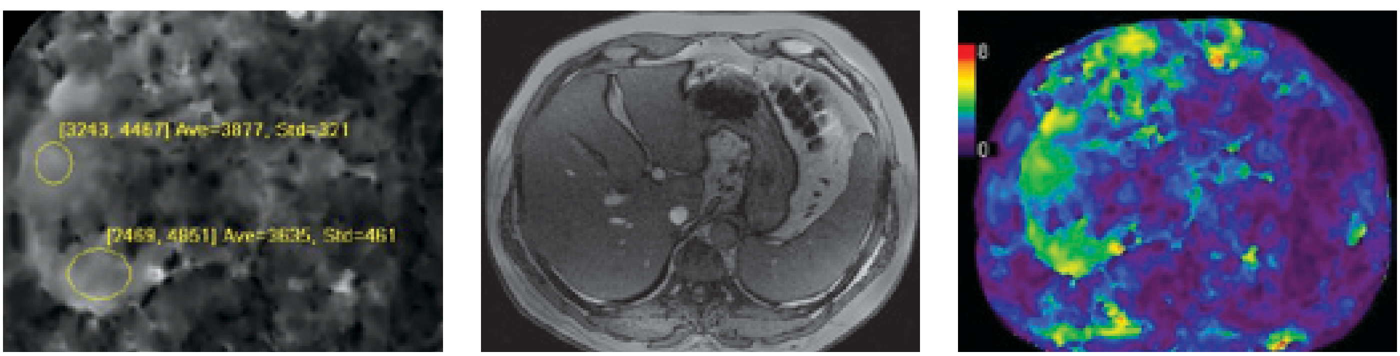


Dr. Coleman Smith

Case 1: A 43-year-old man with elevated LFTs and positive HCV anti-body is referred for hepatology consult. Additional testing showed non-detectable HCV viral load. Positive HCV antibody consistent with either false positive or spontaneous clearance of HCV infection.

MRE Finding: MRE is consistent with mild to moderate fibrosis. Diffuse hepatic steatosis also present at out-of-phase gradient MRI (middle).

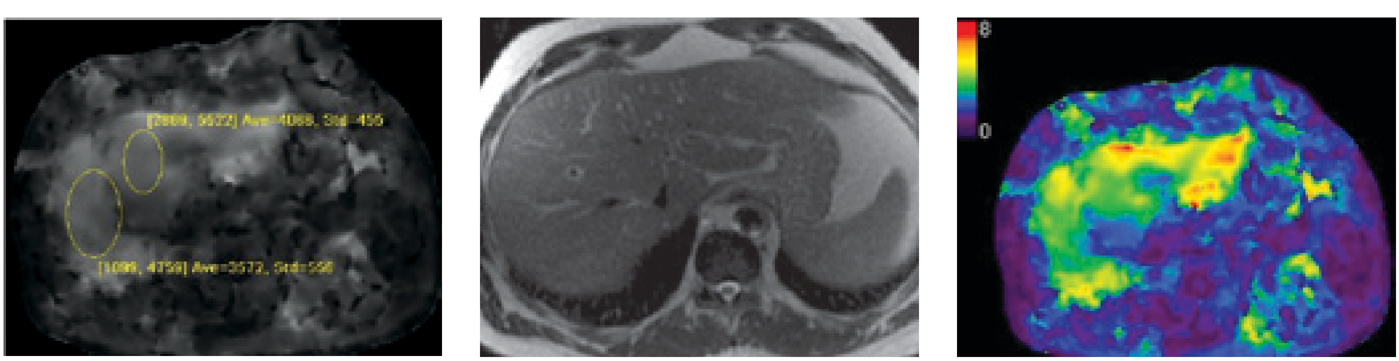
Clinical data and MRI suggest nonalcoholic steatohepatitis (NASH) possibly complicated by fibrosis. Liver biopsy ordered to exclude more advanced liver disease. Pathology results revealed moderate steatosis, mild necroinflammatory activity, and moderate hepatic fibrosis. Biopsy confirms NASH complicated by fibrosis as suggested by MRE.



Case 1.

Case 2: A 57-year-old man with chronic HCV and stage I-II hepatic fibrosis diagnosed at biopsy four years prior presents for hepatology consultation with question of recanalized umbilical vein at recent ultrasound. If present, a recanalized umbilical vein would be an indication to screen endoscopically for esophageal varices.

MRE Finding: MRE yields liver stiffness consistent with stable stage I-II fibrosis. Liver morphology is normal and there are no manifestations of portal hypertension at MRI (middle).



Case 2.

MRE in Clinical Practice: Evaluating Liver Fibrosis without Biopsy

By Sudhakar K Venkatesh, MD, FRCR, Department of Diagnostic Imaging and Seng Gee Lim, MD, FRACP, Department of Gastroenterology and Hepatology, National University Health System

Introduction

The management of chronic hepatitis B and C involves identifying patients at risk of disease progression as not all patients develop complications of liver disease. Guidelines on patient selection for therapy rely on the presence of liver inflammation and fibrosis. Liver inflammation can be evaluated through the use of serum tests. The gold standard for diagnosis of liver fibrosis is liver biopsy.

Liver biopsy has potential complications and consequently patients are often anxious and prefer to avoid this invasive procedure. Chronic hepatitis is treated with antiviral therapy. Many patients with minimal or no fibrosis defer therapy due to the high expense and known side effects of antiviral treatment, but opt for therapy if they have advanced fibrosis. Some patients may also want to know their degree of fibrosis as a general indicator of prognosis. In these cases, the confirmation and accurate staging of disease is necessary.

The traditional gold standard to diagnose and stage chronic liver disease is liver biopsy and consensus groups recommend the routine performance of liver biopsy prior to the initiation of antiviral therapy for chronic hepatitis.[1,2] However, the study by Andriulli et al of 535 patients with viral hepatitis[3] showed that knowledge of the grade and stage of chronic hepatitis were considered of value by the treating physician in only approximately 60% of cases, and antiviral treatment was not changed in 81% of patients. In another study, Saadeh et al show that while biopsy provided useful information regarding staging, prognosis, and treatment decisions, the biopsy did not yield new diagnoses in patients with chronic hepatitis.[4]

Liver biopsy is associated with pain in 30%, severe complications in three per 1,000, and death in three per 10,000 patients.[5] In addition, sampling variability is one of the major limitations of liver biopsy. Recent studies suggest that biopsy is approximately 80% accurate in staging liver fibrosis and may even miss advanced fibrosis of cirrhosis in 30% of patients.[6] This implies that patients with chronic hepatitis who are candidates for antiviral therapy face a decision to undergo a procedure for which there is much apprehension, a finite complication rate, personal and societal costs, and the potential for inaccurate information on disease staging or a missed diagnosis.

A new option for evaluating liver fibrosis is MR Elastography (MRE). MRE non-invasively measures liver stiffness by employing low frequency sound waves in combination with MRI to generate "elastograms." Elastograms are maps of tissue stiffness shown on a color scale ranging from soft to hard.

The following study describes the initial experience of non-invasive evaluation of liver fibrosis with MRE in patients who refused or had contraindications for liver biopsy.

Clinical Study

Thirty-eight patients with chronic hepatitis B (HBV) who refused or had contraindications to liver biopsy underwent an MRE of the liver. Liver fibrosis was suspected in 85% of patients; 15% were receiving treatment and referred from other centers for confirmation of liver fibrosis. The patients' mean age was 57 years. Liver function tests were abnormal in 25% and normal in 75% of patients. Due to perceived unacceptable risk, 90% of the patients refused liver biopsy, while liver biopsy was contraindicated in 10%.

Method

MRE was performed at the end of a routine MRI liver study on a 1.5T MR scanner (GE Healthcare, HDx 15.0). The MRE exam involves a liver MRE sequence with four axial sections of 10mm thickness through the largest axial cross section of the liver. Mean stiffness was calculated by placing a region of interest (ROI) on automatically generated stiffness maps excluding liver edges and major vessels.

Results

MRE was successful in all but one patient who had high liver iron content. One experienced radiologist performed the evaluation of the stiffness maps. Literature reports were used as guidance for differentiating elevated liver stiffness representative of significant fibrosis. Using MRE, 55% of the patients had liver stiffness indicating fibrosis and 42% of the patients had normal liver stiffness.

Management

Liver stiffness from MRE and serum viral DNA levels were considered for management decisions. Among the patients suspected of liver fibrosis, 45% had normal liver stiffness and low serum viral DNA levels and did not receive treatment. Another 16% of patients with mildly elevated liver stiffness and low viral DNA serum levels also received no antiviral therapy and were followed up with regular serum viral DNA and liver function tests. The remaining 38% of patients with elevated liver stiffness and high viral DNA levels received antiviral treatment. Among the six patients who were on antiviral therapy, MRE confirmed fibrosis in four patients and treatment was continued. In two patients with normal liver stiffness, antiviral therapy was stopped in one patient with no detectable serum viral DNA levels while treatment was continued in the other patient with high serum viral DNA levels.

The patients are currently undergoing clinical follow up.

Dr. Sudhakar K. Venkatesh

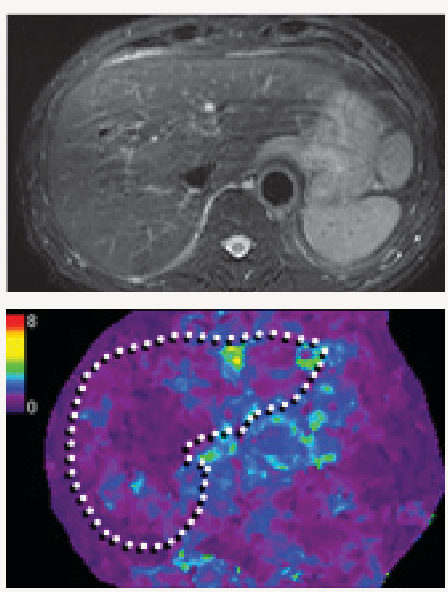
Sudhakar K. Venkatesh, MD, FRCR, is Assistant Professor of Diagnostic Radiology, National University Health System, Singapore. He graduated from Bangalore University in 1994 and completed residency training in Radiodiagnosis at the University of Delhi in 1997 and fellowship training in Radiodiagnosis at SGPGIMS, Lucknow, India in 2000. He completed his clinical fellowship at National University Hospital in 2002 and was awarded Fellowship of the Royal College of Radiologists (FRCR), London, UK in 2003. In 2004, he joined the National University Hospital (NUH). Dr. Venkatesh also completed a one year research fellowship (2006-2007) in MR Elastography at the Mayo Clinic (Rochester, MN). Dr. Venkatesh's research interests are in liver diseases, specifically non-invasive imaging such as MRI. Dr. Venkatesh is the principal investigator of a research project for establishing normal liver stiffness in Asian subjects with MRE and its utility in the diagnosis of liver fibrosis and differentiation of focal liver lesions.

Case One

A 67-year-old male with 30-year history of chronic hepatitis B had HBV load <1000 copies/mL. Liver function tests were normal. The patient refused percutaneous liver biopsy.

MRE Finding

The mean stiffness of the liver was consistent with the absence of fibrosis. The patient is now on regular follow-up.



Dr. Seng Gee Lim

Seng Gee Lim, MD, FRACP, is Associate Professor of Medicine and consultant hepatologist at the National University Health System, Singapore. He also serves as head of the Division of Gastroenterology at NUH and coordinator of the liver research group and is on the editorial boards of Liver International, Gastrohep.com, and Medscape. Dr. Lim graduated in 1980 from Monash Medical School, Australia, completed his fellowship at the Alfred Hospital and was a Clinical Research Fellow at the Royal Free Hospital, London from 1989-1993. He joined NUH in 1995. Dr. Lim's current research interests are molecular biology and immunology of hepatitis, hepatitis B natural history, clinical outcomes, and quality of life issues including investigating hepatitis B lifecycle events. Dr. Lim is also the principle investigator in multiple clinical trials of new hepatitis B treatments.

About the facility

The National University Hospital (NUH), a member of the National University Health System (NUHS), is a tertiary specialist hospital that provides advanced, leading-edge medical care and services. Equipped with state-of-the-art facilities as well as dedicated and well-trained staff, the NUH is a major referral center that delivers tertiary care for a wide range of medical and dental specialties including Cardiology, Gastroenterology & Hepatology, Obstetrics & Gynecology, Oncology, Ophthalmology, Pediatrics and Orthopedic Surgery. It is the principal teaching hospital of the NUS Yong Loo Lin School of Medicine.

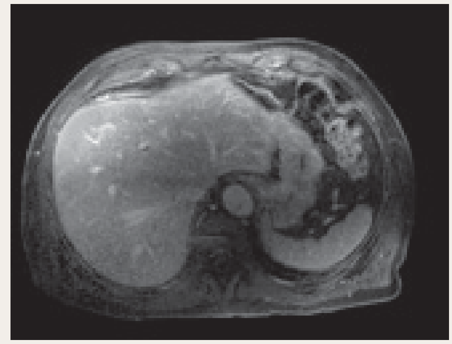
1. National Institute of Health Consensus Development Conference Panel statement: management of hepatitis C. Hepatology 1997;26(suppl 1):2S-10S.
2. European Association for the Study of the Liver. Consensus statement. EASL international consensus conference on hepatitis C. J Hepatol 1999;30:956-61.
3. Andruilli A, Festa V, Leandro G, Rizzetto M, and AIGO members, "Usefulness of liver biopsy in the evaluation of patients with elevated ALT values and serological markers of hepatitis viral infection—An AIGO study", Dig. Dis. Sci. 2001; 46:1409-15.
4. Saadeh S, Cammell G, Carey WD, et al. "The role of liver biopsy in chronic hepatitis C", Hepatology 2001:33:196-200
5. Piccinino F, Sagnelli E, Pasquale G, et al. Complications following percutaneous liver biopsy: a multicenter retrospective study on 68,276 biopsies. J Hepatol1986;2:165–73.
6. Afdhal, NH, "Staging liver fibrosis: Time to abandon liver biopsy?", http://www.natap.org/2005/HCV/080905_01.htm

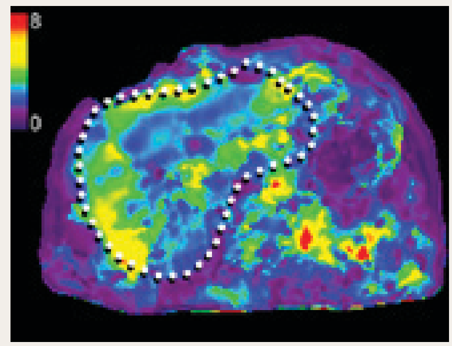
Case Two

A 67-year-old female with chronic hepatitis B presented with high HBV viral load. The patient was allergic to local anesthesia (lignocaine).

MRE Finding

The mean stiffness for the ROI was consistent with that of fibrosis. Antiviral therapy was started without confirmation by liver biopsy.



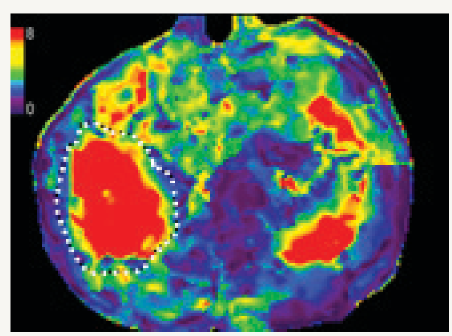


Case Three

A 58-year-old male with chronic hepatitis B and high HBV load refused liver biopsy.

MRE Finding

The mean stiffness of the liver was consistent with that of severe cirrhosis. Antiviral treatment was started one week after MRE.



Summary

For initiation of antiviral treatment, liver stiffness with MRE and viral DNA load influenced clinical decision for antiviral treatment. For patients on antiviral treatment, elevated liver stiffness was interpreted as fibrosis present and antiviral treatment was continued. Liver function tests did not influence decision in the majority of patients.

Liver MRE provides clinicians useful information for detection of liver fibrosis or confirmation of cirrhosis in the management of patients with chronic liver disease. ■

Worth the Wait:
No Compromise Wide Bore Imaging

It's no secret that GE is not the first manufacturer to launch a high field wide bore MR scanner. But what you may not know is the Optima† MR450w 1.5T is delivering on the promise of wide bore done right for clinicians worldwide.

Facilities from across the globe rave about the system's spectacular image quality, unparalleled field of view, exceptional patient throughput, and high level of patient comfort.

For all three facilities profiled—Creil Hospital (Creil, France), Methodist Medical Center of Illinois (Peoria, IL) and Jefferson City Medical Group (Jefferson City, MO)—the Optima MR450w 1.5T was definitely worth the wait.

Dr. Jeffrey Patrick

Jeffrey Patrick, MD, is Medical Director of imaging and a radiologist at Jefferson City Medical Group. He earned his medical degree from the University of Missouri-Columbia School of Medicine and completed his residency at the University of Missouri-Columbia/University Hospital & Clinics. Dr. Patrick is affiliated with St. Mary's Health Center in St. Louis and is a member of the Alpha Omega Alpha Medical Honor Society.

Images courtesy of Jefferson City Medical Group.

Figure 1. Optima MR450w 1.5T delivers high homogeneity for enhanced large FOV and off center FOV imaging and robust fat saturation for imaging structures such as the abdomen (extends well beyond the FOV center) and extremities (that can't be positioned in the center of the magnet).

All about image quality

In 2008, Creil Hospital received authorization to add a second MR scanner. While pleased with the performance and quality of the site's existing scanner—a Signa† HDxt from GE Healthcare—wide bore technology was emerging. However, image quality on the existing wide bore systems was not up to the facility's satisfaction, explains Jean-Marc Pinon, Manager of CT/MR. "Whether it was about image quality or the user interface, these systems were not comparable with the excellent results we had on our Signa HDxt."

That all changed when Creil was invited to take a sneak peek at the Optima MR450w 1.5T during production in Waukesha, WI. "We were impressed with the results on the Optima MR450w 1.5T," adds Pinon. "Not only was the overall quality of the exams really good, but the system obtained superior image quality [compared to the Signa HDxt], despite the 70cm bore. There was no compromise!"

Jefferson City Medical Group (JCMG) had a similar initial experience with GE's new wide bore technology. Jeffrey Patrick, MD, JCMG Medical Director of Imaging and radiologist, knew that when their open MRI lease was up the practice would replace it with a wide bore system. But he wasn't impressed with the image quality he saw on wide bore systems—that is until he had a chance to preview the Optima MR450w 1.5T.

"We thought the images from the GE system were outstanding. We were so early in the process, there was a leap of faith (with the GE system)," Dr. Patrick explains. "As it turned out, our expectations have been met and exceeded. The Optima MR450w 1.5T provides dramatically better image quality than the other wide bore systems available."

In fact, today he prefers the wide bore for every MR study. "I can't think of any study that is not better on the Optima MR450w 1.5T than on our other 1.5T HDxt system," he says.

Across the Mississippi River, Methodist Medical Center of Illinois was also replacing an open MR. Margo Funk, RT (MR), Lead MRI Tech, explains, "The open MR would not always accommodate the 350 lb cardiac patient's body habitus or girth, so our bariatric inpatients were being sent to another Methodist facility for MR scanning."

Methodist's Tony Howard, Director of Emergency Services and Medical Imaging, evaluated existing open bore MRs and found the Optima MR450w 1.5T met the hospital's three core competencies—operational, service, and clinical excellence.

James A. McGee, MD and radiologist at Methodist, adds, "Our focus is quality first and we evaluate all equipment based on the imaging need." Although Methodist purchased GE's wide bore system, the facility was renovating the MR room prior to installation. The hospital rented a different manufacturer's wide bore scanner and set it up in a trailer connected to the facility in the interim.

> "The Optima MR450w 1.5T provides dramatically better image quality than the other wide bore systems available."
>
> *Jeffrey Patrick, MD, Jefferson City Medical Group*

"We are extremely satisfied with the results."

Jean-Marc Pinon, Creil Hospital

Mr. Jean-Marc Pinon

Jean-Marc Pinon is the Radiology Manager at the CT and MR imaging center based at the regional hospital CHR Laennec of Creil, France. He holds a national degree in electroradiology. Mr. Pinon started his career in radiology in 1986 at CCN where he spent 14 years. After CCN, he served in different private imaging centers in France as a consultant and applications engineer.

Images courtesy of Creil Hospital.

Figure 2a. Optima MR450w 1.5T delivers large FOV anatomical coverage with a 50x50x50 cm useable FOV.

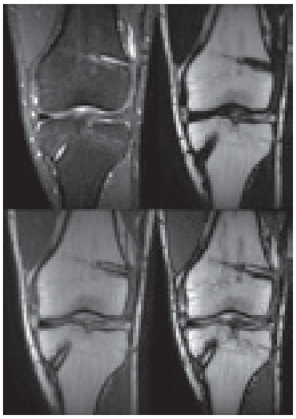


Figure 2b. IDEAL, a GE innovation, generates up to four image types from a single scan enhancing diagnostic utility.

"When I first saw the images from the rented MR, I thought that they were pretty good," Dr. McGee says. "But over the next several months, we became less satisfied with the magnet performance. We definitely made the right decision, the images are beautiful on the new GE wide bore."

No imaging limitations

For Pinon at Creil, GE's wide bore seems to "have no limitations with regards to coverage of any anatomical region or large field of views." Clinical investigations of FOVs at 40 or 50 cm are without artifacts, he says. "We are extremely satisfied with the results."

Dr. McGee is also impressed with vascular imaging study results. With these studies on other manufacturers' systems, he encountered numerous issues with post processing 3D and maximum intensity projections (MIPs). "I was frustrated with the pages of notes and keystrokes needed to do this. So, I loaded it onto the GE system and with one click, it was done. GE really thinks about that—how we use the data—and they are always trying to get it right."

Although Methodist has added cardiac exams for larger patients, it is the orthopedic and body imaging that Dr. McGee singles out. The SNR is better, he says, with fewer artifacts or shim problems, and the system provides more uniform, reliable fat suppression thanks to IDEAL.

These same results are seen at JCMG. Spine and orthopedic surgeons have noticed the biggest jump in image quality, says Dr. Patrick. "They care for a lot of larger-sized patients and require detailed imaging," he explains. "They are most pleased with the improvement in image quality as compared to open or other wide bore systems in the area."

Faster exams, higher throughput

All three sites installed the Optima MR450w 1.5T by late summer 2010, and while they can't yet credit the system with increasing referrals, there is a definite impact on patient throughput and volume.

Randy Fuhrman, RT, Manager of Diagnostic Imaging at JCMG, can now add additional patient scanning slots to his MR schedule thanks to the speed and efficiency of the new wide bore. "We are now able to accommodate same day add-ons thereby increasing volumes," he explains. "The system has increased our efficiency and patient satisfaction—they aren't on the table as long as they were with the open magnet." In fact, Fuhrman notes that the volume of MSK exams has increased by 18% since the installation of the wide bore MR.

Dr. James A. McGee

James A. McGee, MD, is a radiologist at Methodist Medical Center, Peoria, IL. He received his medical degree from the University of Iowa, College of Medicine (Iowa City, IA), completed a transition internship at La Crosse Lutheran Hospital (La Crosse, WI) and served his radiology residency at Northwestern University in Chicago. Dr. McGee also completed a fellowship in body imaging at the University of Iowa Hospitals and Clinics.

Images courtesy of Methodist Medical Center.

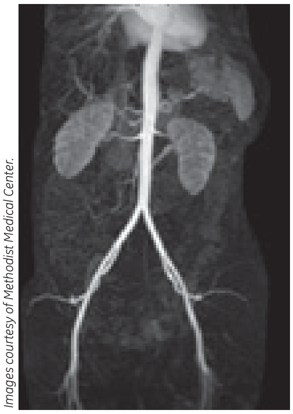


Figure 3a. The large FOV anatomical coverage of Optima MR450w 1.5T extends imaging capability.

Figure 3b, c. Optima MR450w 1.5T provides access to GE's complete applications portfolio, including the Inhance non-contrast MRA suite. Inhance does not require contrast or cardiac gating and thus simplifies both set-up and scanning.

The technology on the Optima MR450w 1.5T has changed so much, adds Janet Harris, RT(R), Lead MR Tech at JCMG, that most exams are completed in 15 to 20 minutes. "It is amazing what we can do with one sequence, such as IDEAL—water only, fat only, and fat sat all in coronal or sagittal views." Overall, exam times are 80% shorter on the wide bore than the open—and the practice can now scan three to four patients per hour.

While scanner speed and shorter scan times greatly impact patient throughput, Orvalee Roe, Operations Manager for MRI, NM and PET at Methodist, credits another GE innovation. "The detachable table has a huge impact on patient throughput and safety," she says. "We can set up one patient on the second table while another is being scanned. It also eliminates pain of [the tech] lifting coils and we can more easily attend to the patient if they go into a code."

Roe anticipates patient volume growth for vascular studies with Inhance non-contrast MRAs. "Before, we couldn't image patients with low GFRs. Now, we have an option that benefits our patient community."

Similarly, Creil did not previously perform any cardiac MR exams. With the Optima MR450w 1.5T, the facility conducted more than 70 in just one- and one-half months.

Fewer retakes also streamline patient throughput, notes Creil's Pinon. "The wider bore dramatically enhances patient comfort, particularly with our oncology patients, and we've noticed fewer issues and retakes due to claustrophobic or obese patients." Patients appreciate the wider and shorter bore, he adds. During his volunteer scan, Pinon noticed the system was much quieter than the facility's other MR scanner.

Ease of use

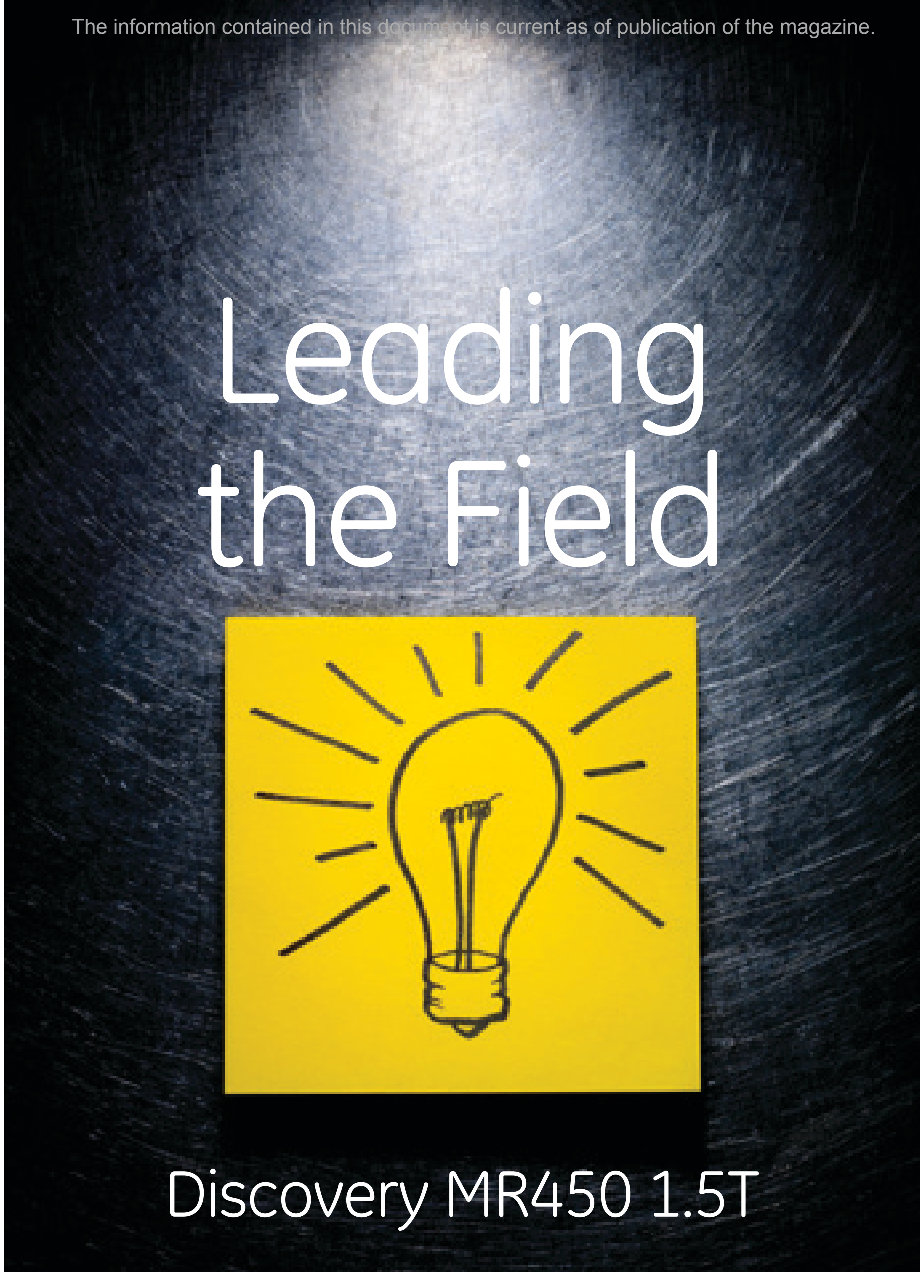
Across all three sites, the techs complement GE for developing a user interface that is easy-to-use and compatible with other GE MR platforms. Pinon credits shorter scan times and better reproducibility of exams to the new user interface. Methodist's Roe finds the techs are more confident performing studies with GE's simplified interface—nothing is hidden or requires multiple steps or buttons to perform. Harris at JCMG believes improvements in software have streamlined the techs' workflow.

"A 'copy sequence' feature lets us automatically copy protocols for the same type of scan in the same plane and auto links each sequence to the others," Harris says.

Exceptional image quality, advanced applications, enhanced patient comfort, and an easy-to-use interface enable these sites to elevate the value of MR imaging to their physician and patient community. As the world of MR continues to change, GE's Optima MR450w 1.5T offers facilities the right capabilities to confidently diagnose and expand their clinical offerings and provide patients the right MR experience. ■

"We definitely made the right decision, the images are beautiful on the new GE wide bore."

Dr. James McGee, Methodist Medical Center

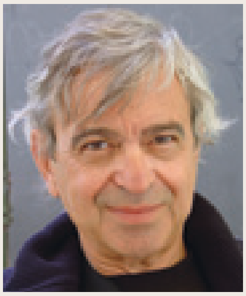


Leading the Field

Discovery MR450 1.5T

Today, the MRI equation may seem complex. MRI has become a key modality for routine and advanced clinical studies in a wide range of clinical situations. At the same time, the present challenging economic environment forces us to focus also on productivity. At CCN, our Discovery† MR450 1.5T offers a robust and powerful MR system with uncompromised quality and increased patient throughput. With its strong whole body gradients, ultra-fast reconstruction for real-time parallel imaging, anatomy-optimized RF coils, and a large set of applications, our MR scanner is living up to its promise. We believe these capabilities will continue to maximize the value of our investment and keep us at the forefront of technology for many years. The equation may be complex but we've found the right solution. Following are several clinical cases that our Discovery MR450 has helped to elucidate.

Jean-Louis Sablayrolles, MD
Head of CT & MR Radiology



Dr. Jean-Louis Sablayrolles

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

Dr. Vincent Barrau

Vincent Barrau, MD, is an associate radiologist at Centre Cardiologique du Nord (CCN), Saint Denis, and is a part time abdominal radiologist at Hospital Beaujon, Clichy and Hospital Avicenne, Bobigny (all in France) Dr. Barrau completed his Abdominal Fellowship at Hospital Beaujon and specializes in abdominal radiology.

LAVA Flex

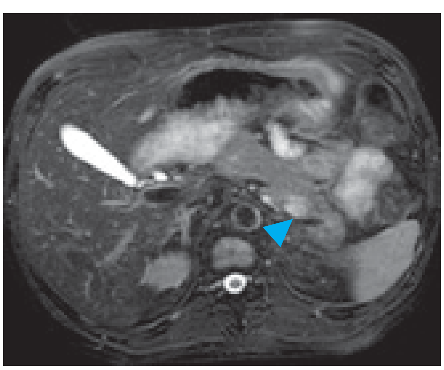
LAVA Flex is a high-resolution volume imaging technique with water and fat separation. LAVA Flex is based on the standard LAVA sequence modified to acquire two echoes at in-phase and out-of-phase echo times within the same breath hold. It generates water-only, fat-only, in-phase, and out-of-phase images from a single scan.

LAVA Flex improves the visualization of small lesions, and makes it possible to reformat the 3D dataset into any slice orientation with an almost isotropic resolution.

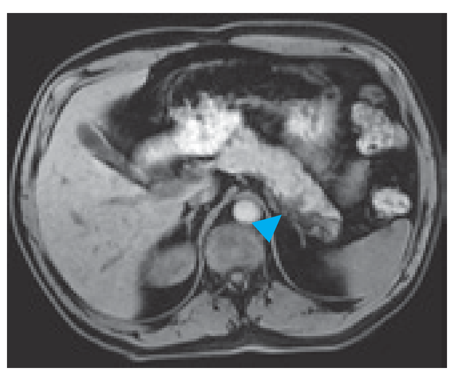
Contributor: Vincent Barrau, MD

Case 1. MR imaging of abdominal lesions

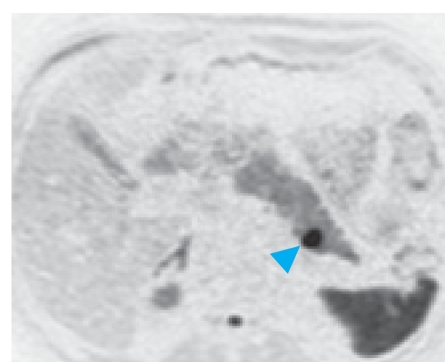
Patient history: 58-year-old male. Staging of a primary bronchial lesion with PET/CT showed a suspicious lesion in the tail of the pancreas. Combining T2 FRFSE, LAVA Flex and DWI, MRI was used to confirm the lesion found with PET.



2D axial T2 FRFSE with fat sat
TR: 13636 ms; TE: 85.6 ms
Spatial resolution: 0.85 x 0.85 x 4 mm^3
Slice thickness: 4 mm
Respiratory triggering
Scan time: 3:38



3D axial LAVA Flex, water image
TR: 6.2 ms; TE: 2.1 and 4.2 ms
Spatial resolution: 0.89 x 0.89 x 1.9 mm^3
Slice thickness: 3.8 mm, zip 2
Parallel imaging ARC
Scan time: 0:20

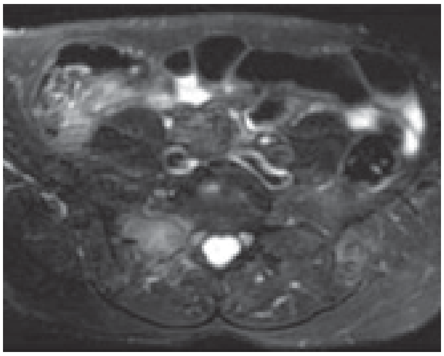


2D axial EPI-DWI b = 800
TR: 5455 ms; TE: 71.2 ms
Spatial resolution: 3.125 x 3.125 x 4 mm^3
Parallel imaging: ASSET
Slice thickness: 4 mm
Respiratory triggering
Scan time: 1:33

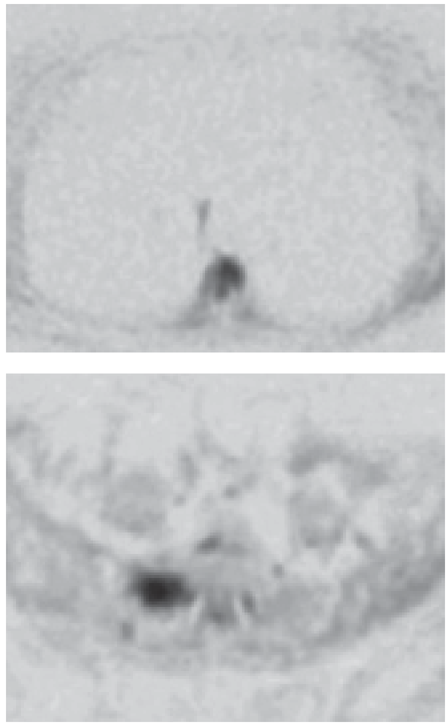
Finding: LAVA Flex, with the reconstruction of four contrasts in a breath hold (in-phase, out-of-phase, water and fat images) helps to improve exam workflow with excellent contrast for abdominal studies.

Case 2. Detecting lesions with whole-body MRI

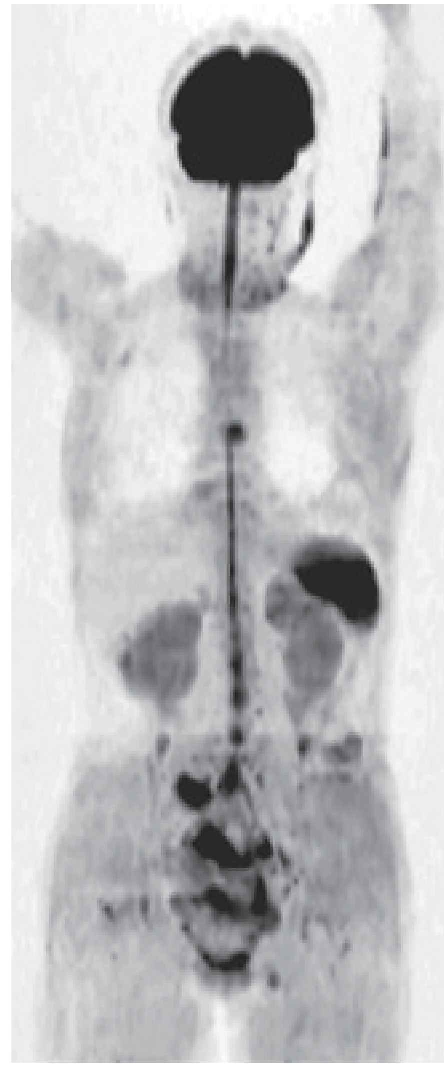
Patient history: A 65-year-old female with known breast cancer. Whole-body MR exam was performed for detection of distant lesions.



2D axial T2 FRFSE with fat sat
TR: 13636 ms; TE: 85.6 ms
Spatial resolution: 0.85 x 0.85 x 4 mm^3
Slice thickness: 4 mm
Respiratory triggering
Scan time: 3:38



2D axial STIR-EPI-DWI b = 800
TR: 5525 ms; TE: 53.7 ms; TI: 160 ms
Spatial resolution: 3.43 x 3.43 x 8 mm^3
Slice thickness: 8 mm
Respiratory triggering
40 slices per station, 3 stations in total
Total scan time: 4:36



3D MIP coronal view from axial
STIR-EPI-DWI b = 800
3 stations pasted and reformatted in coronal

eDWI

eDWI takes diffusion MRI to the next level of performance. A STIR pulse greatly improves the robustness of fat suppression and the respiratory triggering option makes breath hold unnecessary. The results are improved SNR and more accurate ADC maps in shorter scan times.

Finding: Enhanced DWI (eDWI) is reliable and reproducible over a wide range of anatomies and, with the STIR pulse, can be used for whole-body examinations.

Dr. Mathieu H. Rodallec

Mathieu H. Rodallec, MD, is an associate radiologist at Centre Cardiologique du Nord (CCN), Saint-Denis, France, and is a part time Head and Neck radiologist and neuroradiologist at Saint-Joseph Hospital in Paris, France. Dr Rodallec completed his Fellowship at Hospital Beaujon, Clichy, France. He has published training material, authored publications and abstracts and has given numerous presentations at educational meetings. He is a member of the French Society of Radiology (SFR), French Society of Neuroradiology (SFNR) and Radiological Society of North America (RSNA).

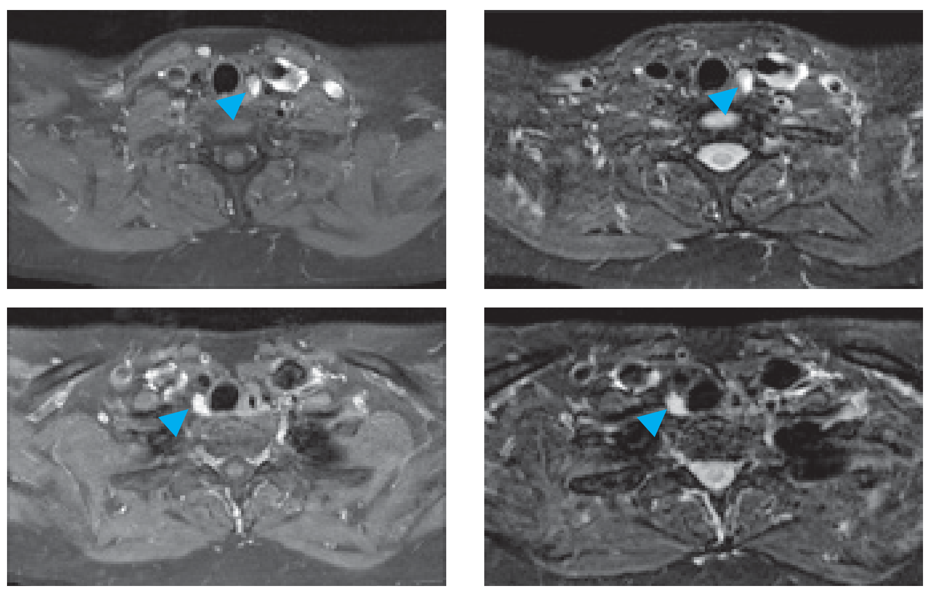
FSE IDEAL

IDEAL is an innovative solution for water and fat separation imaging, even in the most challenging areas of the anatomy. IDEAL is a 2D FSE sequence, producing four contrasts: water only, fat only, in-phase and out-of-phase. Available for each contrast weighting (T1, T2 and PD) and each anatomy. How does it work? Separation of water and fat, using three echoes and mathematical phase-based reconstructions. Resulting images are very homogeneous.

Contributor: Mathieu H. Rodallec, MD

Case 1: Bilateral parathyroid adenoma

Patient history: 30-year-old female. Patient suffering of hypercalcemia. Only one adenoma detected with ultrasound.



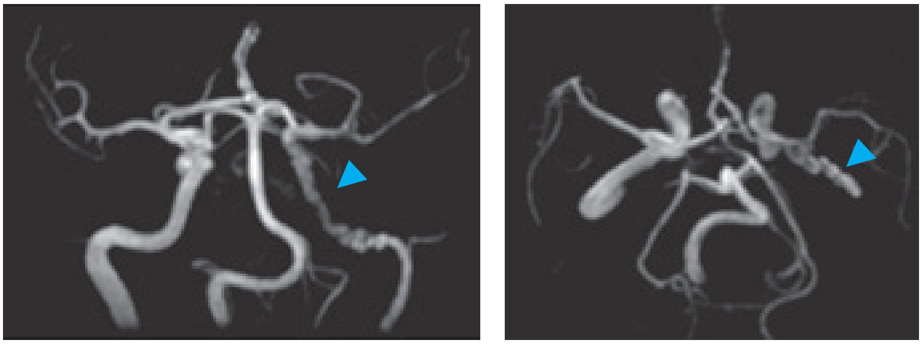
Left
2D axial IDEAL T1, water images
Post contrast Imaging
TR 762 ms, TE 12.4 ms
Spatial resolution 0.75 x 0.93 mm²
Slice thickness 4 mm
Scan time 3:49 min

Right
2D axial IDEAL T2, water images
TR: 5220 ms; TE: 71.8 ms
Spatial resolution: 0.68 x 1.07 mm²
Slice thickness: 4 mm
Scan time: 3:55

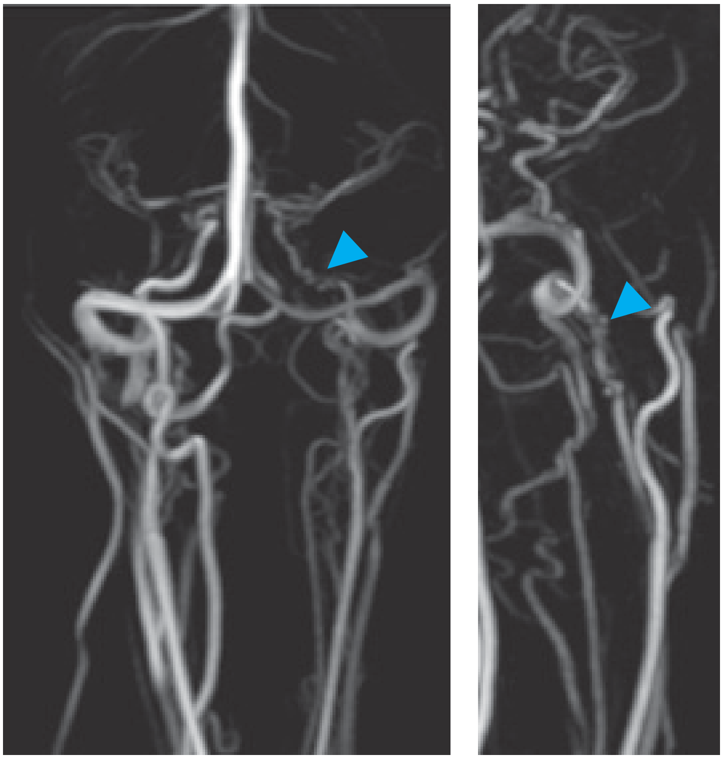
Finding: The MR assessment with the IDEAL fat suppression sequence showed a second contralateral lesion. IDEAL enhances the pathology in T2 and T1 post contrast especially in difficult anatomies, resulting in better detection.

Case 2. Carotid fibrodysplasia

Patient history: 54-year-old female, suffering of fibrodysplasia (irregularity of vessels wall). MR assessment of carotids.



Non-contrast enhanced 3D TOF
TR: 21 ms; TE: 3.4 ms
Spatial resolution: 0.56 x 1 mm²
Slice thickness: 1.2 mm
Scan time: 2:34

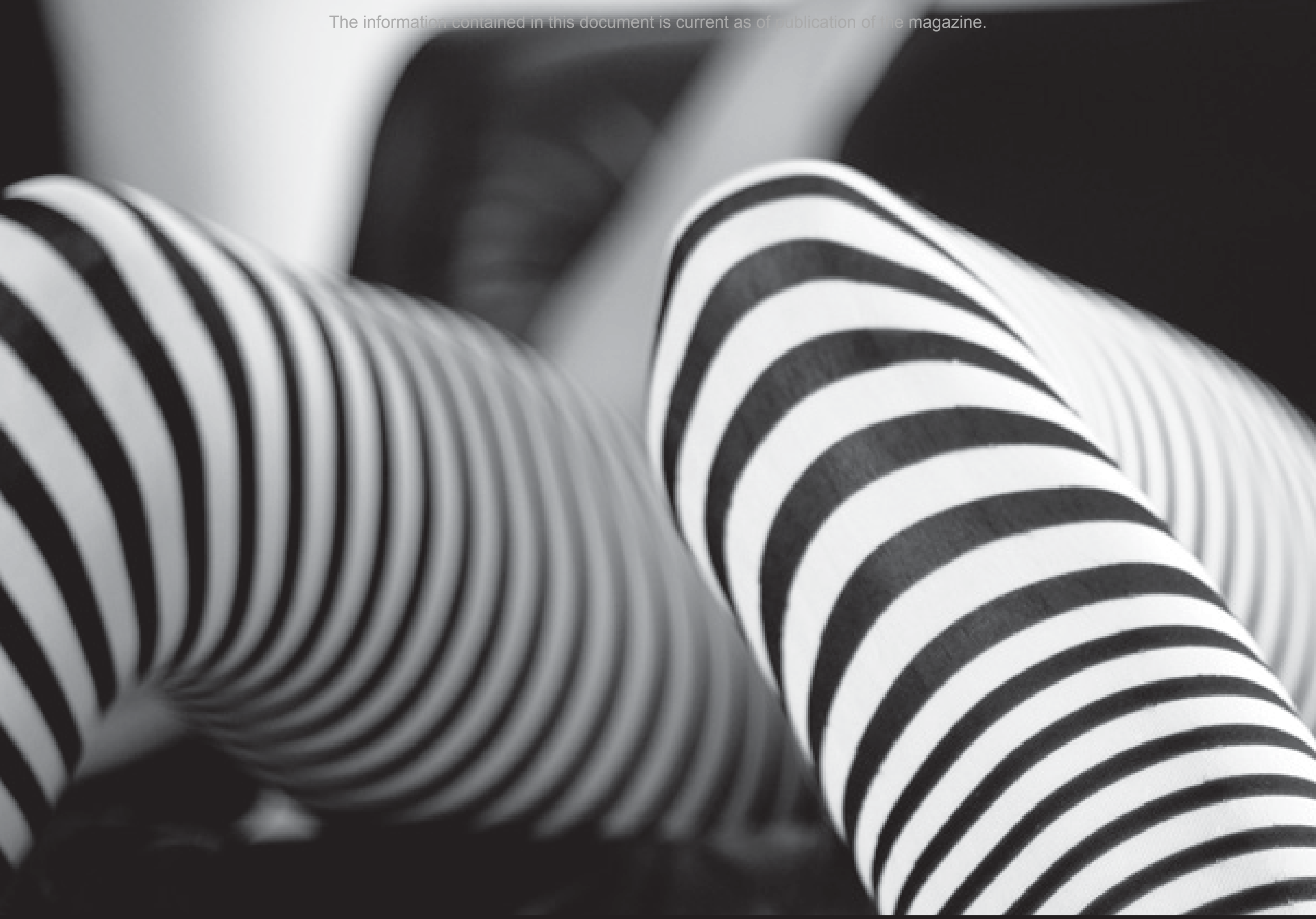


Non-contrast enhanced 3D Velocity
TR: 9.7 ms; TE: 4.9 ms; Encoding velocity: 40
Spatial resolution: 1.125 x 1.4 mm²
Slice thickness: 2 mm
Scan time: 4:18

Finding: These techniques clearly demonstrate parietal irregularities consistent with fibrodysplasia. 3D Velocity can be helpful to explore the supra-aortic trunks. ■

About the facility

The Centre Cardiologique du Nord (CCN) is a private practice created by a group of cardiologists in 1973 in Saint-Denis, France. CCN is considered a center of excellence in the diagnosis and treatment of cardio-vascular diseases, performing cardiac and vascular MR since 1998. However, abdominal, neurological and muskuloskeletal imaging also represent an important part of CCN's MR workload. Today, with two MR scanners, a Signa HDxt 3.0T and the recently installed Discovery MR450 1.5T, CCN is equipped to address the most challenging diagnostic situations. CCN also operates two GE Healthcare's CT scanners, a LightSpeed† VCT XT and a Discovery CT750 HD.



Single Acquisition of the Entire Knee Joint: 3D Has a Leg up on 2D

By Eric Pessis, MD, Centre Cardiologique du Nord (CCN)

Two-dimensional fast spin-echo (FSE) is a powerful clinical tool, yet it suffers from anisotropic voxels, slice gaps, and partial volume effects. Three-dimensional FSE (3D FSE), with flip angle modulation to reduce blurring and parallel imaging to decrease imaging time, has made isotropic imaging with spin echo contrast a clinical reality.[1] Several studies using 3D FSE with isotropic resolution in the knee and ankle have been published.[1-5]

Cube, GE Healthcare's 3D FSE sequence, can produce multiplanar 3D intermediate-weighted images with 0.6 mm isotropic resolution at 3.0T in a single acquisition. The Cube sequence also produces images with intermediate weighted contrast, which is the most commonly used tissue contrast in musculoskeletal MR imaging today. Three-dimensional isotropic resolution sequences can also reduce partial-volume artifacts through the acquisition of thin continuous sections through the joints.

Kijowski et al, have demonstrated that the Cube sequence has similar diagnostic performance as a routine MR imaging protocol in the detection of various lesions or ligament tears within the knee joint at 3.0T.[3]

Anatomical studies demonstrate the native anterior cruciate ligament (ACL) consists of two distinct functional bundles—the anteromedial (AM) and posterolateral (PL)—based on their tibial insertions. However, due to oblique course of the ACL, it is not well visualized throughout its entire length on standard orthogonal views. A 3D FSE sequence allows oblique reformatted images in planes that are based on the ligament's natural course and demonstrate the AM and PL bundles within the ACL.

In our daily practice with a Signa† HDxt 3.0T MR, oblique reformatted images with an increase in the signal-to-noise ratio (SNR) and fewer partial-volume artifacts allows a more accurate assessment of the ACL.

Case 1. Cartilage Lesions

Figure 1. Small lesion at the central weight-bearing medial femoral condyle. Fat-suppressed intermediate-weighted FSE image of medial femoral condyle shows a full-thickness cartilage lesion at the central weight-bearing medial femoral condyle.

Figures 2, 3. Corresponding sagittal and coronal images reformatted from fat-suppressed 3D isotropic Cube intermediate-weighted MR data. The small lesion is best visualized with Cube. The higher sensitivity of Cube for detecting cartilage lesions is most likely secondary to reduced partial-volume averaging.

Figures 4, 5. Sagittal and coronal images reformatted from fat-suppressed 3D isotropic Cube intermediate-weighted MR data show an irregular articular surface of the lateral femoral condyle.

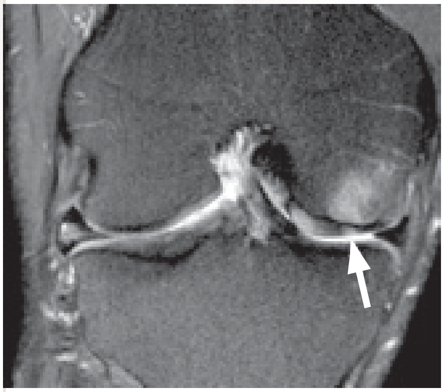


Figure 1

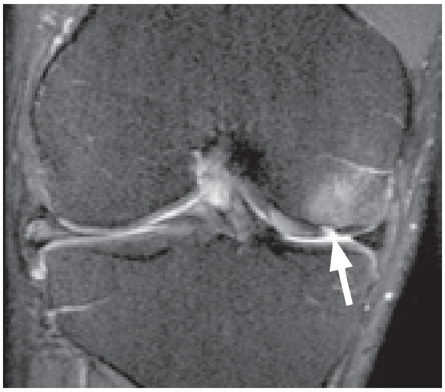


Figure 2

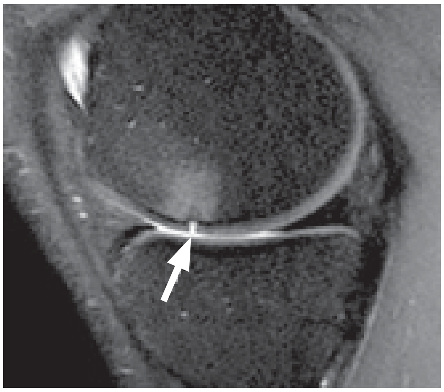


Figure 3

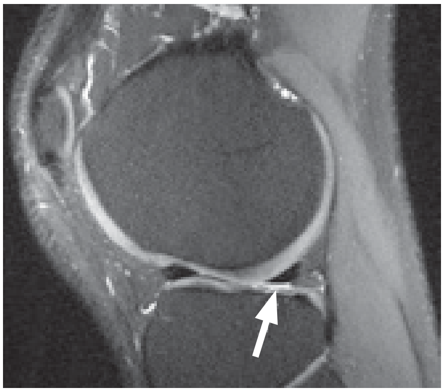


Figure 4

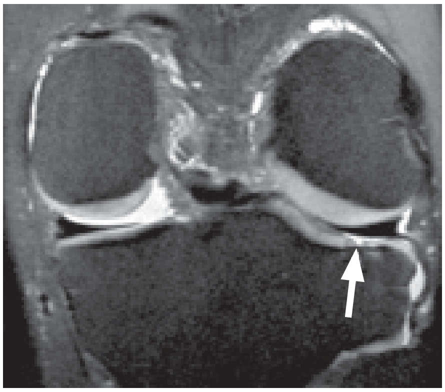


Figure 5

Case 2. Cruciate Ligament

Figure 6. Coronal reformatted image from fat-suppressed 3D Cube intermediate-weighted MR data shows two bundles in an intact ACL. Because of its oblique course, however, the ACL is not well visualized throughout its entire length.

Figure 7. Axial reformatted image shows the AM and the PL bundles in an intact ACL.

Figures 8 to 11. Oblique reformatted images in planes that are based on the natural course of the ligament demonstrate the AM and the PL bundles in an intact ACL. Oblique imaging planes, combined with an increase in the SNR and resolution, allow a more accurate assessment of both bundles of the ACL.

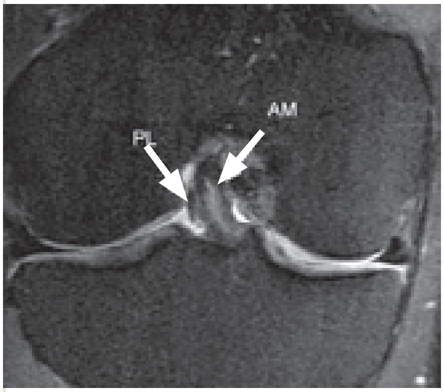


Figure 6

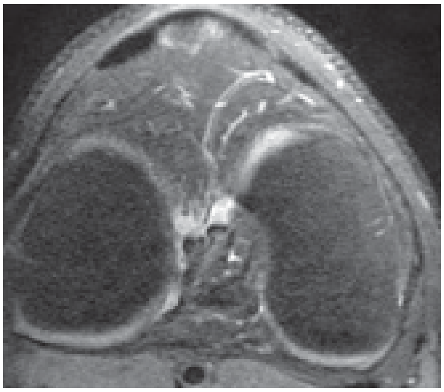


Figure 7

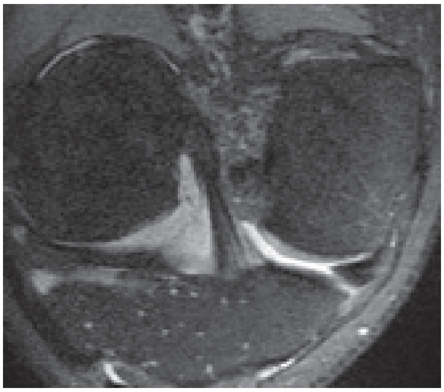


Figure 8

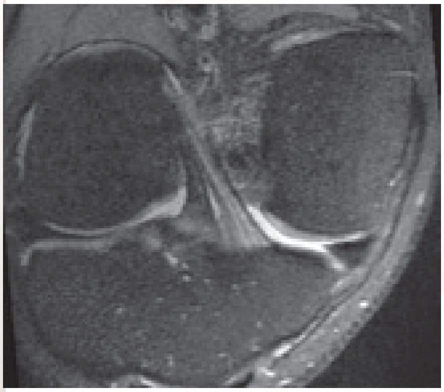


Figure 9

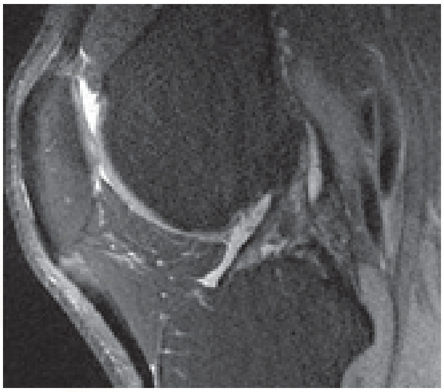


Figure 10

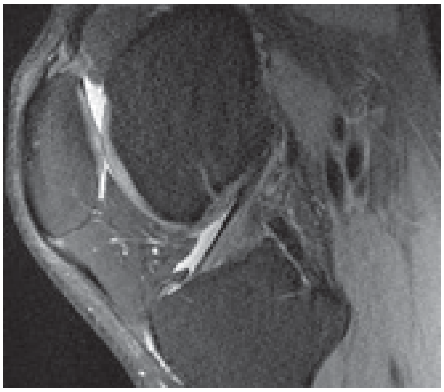
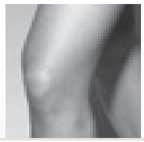


Figure 11

The use of 3D Cube high-spatial-resolution sequences are likely to markedly enhance the diagnostic capabilities of MR imaging for subtle lesions. At 3.0T, the Cube sequence reduces partial-volume artifacts by acquiring thin continuous sections through the joints. In our facility, this allows our radiologists to detect small lesions that are barely seen with conventional 2D FSE sequences.

In conclusion, 3D Cube high-spatial-resolution sequences with a 3.0T MR unit achieve isotropic resolution for the entire joint in a single acquisition. The isotropic source data can be used to create multiplanar reformations, thereby eliminating the need to repeat sequences with identical tissue contrast in multiple planes without impacting diagnostic performance compared to a routine MR imaging protocol. In our experience, small lesion defects are better visualized at 3.0T, which leads to a more accurate assessment of both ACL bundles. ■



Case 3. Meniscus

Figure 12. Displaced bucket-handle tear of the medial meniscus. Sagittal reformatted image shows a meniscal tear of the posterior horn and a double anterior horn.

Figure 13. Axial reformatted image shows a large fragment in the intercondylar notch.

Figure 14. Meniscal fragment displaced in the superior recess of the medial meniscus. Coronal fat saturated image shows truncation of the body of the medial meniscus and a low-signal-intensity meniscal fragment flipped in the superior meniscal recess.

Figure 15. Transverse fat-saturated image shows a meniscal fragment deep to the capsule and anterior to the medial collateral ligament.

Figure 16. Transverse fat-saturated image shows truncation of the body of the medial meniscus.

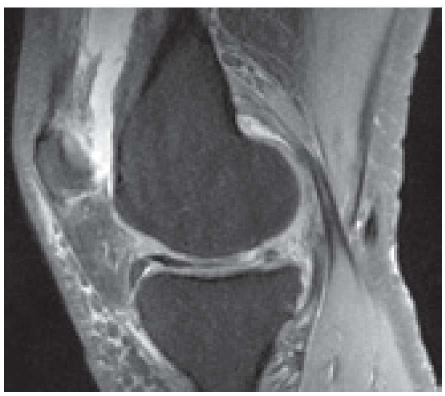


Figure 12

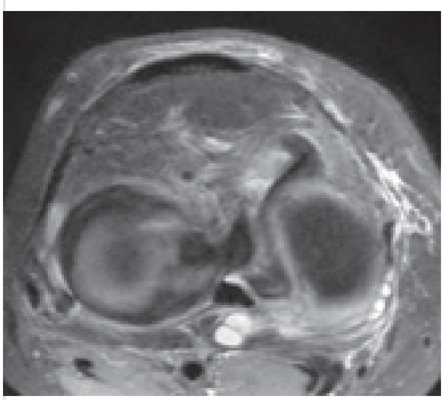


Figure 13

Figure 14

Figure 15

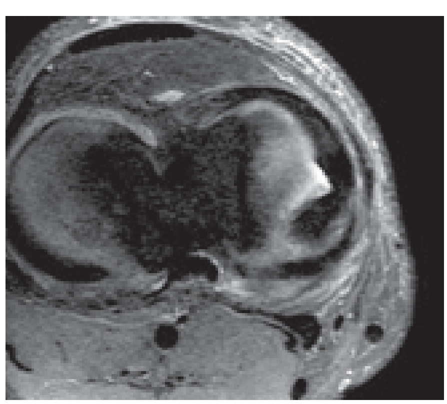
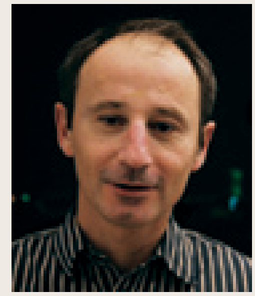


Figure 16



Dr. Eric Pessis

Eric Pessis, MD, is a radiologist at Centre Cardiologique du Nord (CCN) in Saint Denis, France since 2001. He specializes in MSK imaging. Prior to joining CCN, Eric Pessis completed his internship and residency in radiology in various prominent public hospitals in the region of Paris, such as CHU de la Pitié Salpêtrière, CHU de Kremlin-Bicêtre or CHU Cochin from 1988 to 1994. He also served as Chief Physician Assistant at the MSK radiology department of CHU Cochin in Paris between 1995 and 1998.

He has co-authored numerous articles and several book chapters in the field of MSK and has often presented at national and international symposia and conferences, including RSNA. He is also a peer-reviewer of the American Journal of Roentgenology.

About the facility

The Centre Cardiologique du Nord (CCN) is a private practice created by a group of cardiologists in 1973 in Saint-Denis, France. CCN is considered a center of excellence in the diagnosis and treatment of cardio-vascular diseases. Abdominal, neurological and muskuloskeletal imaging also represent an important part of CCN's MR workload. Today, with two MR scanners, a Signa† HDxt 3.0T and the recently installed Discovery† MR450 1.5T, CCN is equipped to address the most challenging diagnostic situations. CCN also operates two GE Healthcare's CT scanners, a LightSpeed† VCT XT and a Discovery CT750 HD.

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3. Kijowski R, Davis KW, Woods MA, et al. Knee joint: comprehensive assessment with 3D isotropic resolution fast spin-echo MR imaging—diagnostic performance compared with that of conventional MR imaging at 3.0 T. Radiology 2009; 252:486-495.
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Scan the Renals, Hold the Contrast

Inhance Inflow IR gives patients with renal insufficiency new opportunities for non-invasive diagnosis

Every so often, a new MR sequence opens the door to a new era of patient management by providing valuable diagnostic information for patients who otherwise would not be scanned. It demonstrates clear benefits for patients, clinicians, and imaging facilities. Inhance Inflow IR, a new MR sequence from GE Healthcare that provides consistent, high-quality images of the renal arteries without contrast, is one of these sequences.

"It is a frequent challenge to detect renal artery stenosis in a patient with renal insufficiency," says David Klein, MD, Radiologist at Norwalk Radiology & Mammography Center. "Our strategies are limited when we are unable to give an iodine- or gadolinium-based contrast agent."

In mid-2009, Norwalk tried Inhance Inflow IR with GE's eFlexTrial program and in January 2010, purchased it for use on patients.

"Inhance Inflow IR is a very valuable technique," says Linda Richardson, R.T. (R)(M)(MR)(CT), Lead MRI Technologist at Norwalk. "We are able to offer studies to patients who, in other circumstances, could not receive contrast and therefore, could not receive the study. It is exciting that we have something new to offer area referrals."

"This really is a holy grail—we now have a test that can provide an excellent look at the renal arteries and cause no toxicity doing it."

Dr. David Klein

In fact, several nephrologists were informed in advance that Norwalk would have this new capability. "We had a list of patients who were waiting for us to offer Inhance Inflow IR," adds Stephen Spader, R.T. (R)(CT)(MR), Chief Technologist.

Having a new MR imaging capability is only half the battle. Generating high quality, diagnostic images that rival the existing standard of care is necessary to support clinical efficacy.

"During our trial period I thought the images we acquired on normal volunteer renal arteries were highly predictive," explains Dr. Klein. "The signal was strong, the definition was very sharp, and, interestingly, I thought I could see with better definition the more distal intrarenal arteries than we see with existing techniques today."

Dr. Klein finds a high correlation between renal artery stenosis on Inhance Inflow IR and existing techniques. "This really is a holy grail—we now have a test that can provide an excellent look at the renal arteries and cause no toxicity doing it."

Spader stresses that anytime a new MR pulse sequence is run, it is compared to the current standard to demonstrate value, reliability, and accuracy. At Norwalk, each patient referred for a renal study is also given an Inhance Inflow IR study.

The results have been impressive. Dr. Klein can confidently make a diagnosis of normal renal arteries as well as those with significant steno-occlusive disease.

Inhance Inflow IR is also very user friendly. Richardson notes that it is easier to set up and use than the traditional methods. The sequence is set to run as is, she explains. "All the MRI technologist has to do is position the patient for the exam, put the respiratory bellows on, and prescribe the Inhance Inflow IR sequence centering over the renal arteries."

In just six months after installation, Norwalk conducted 45 Inhance Inflow IR studies on patients referred by either internists or nephrologists. "That's the neat thing about Inhance Inflow IR; it captures a new range of patients," Spader says. "One hundred percent of these patients would not have otherwise been scanned." He estimates the 2010 volume will add 75 to 80 new patients thanks to Inhance Inflow IR.

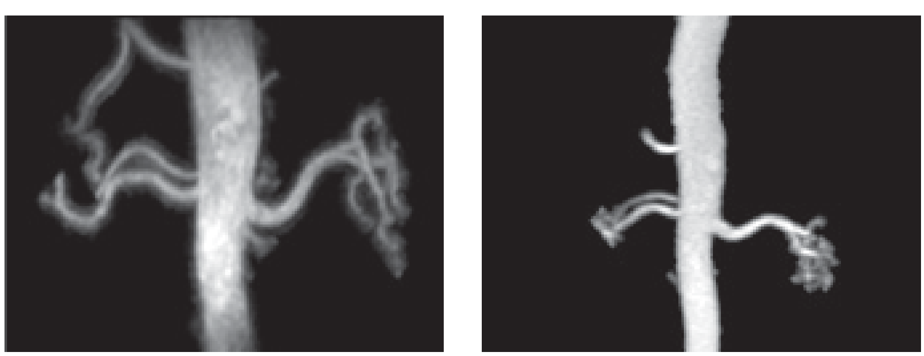
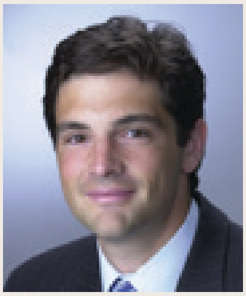
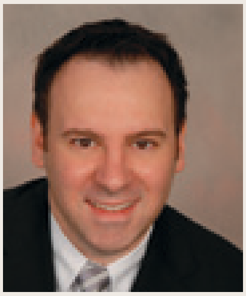


Figure 1. Duplicated right renal artery using Inhance Inflow IR (left). Duplicated right renal artery contrast enhanced SPGR (right).



Dr. David Klein

David Klein, MD, is a radiologist with Norwalk Radiology and Mammography Center. Dr. Klein received his degree in medicine from New York University School of Medicine in 1995. Dr. Klein completed a one-year Internal Medicine Internship in 1996 and a four-year diagnostic radiology residency from 1996 to 2000 at New York University Medical Center and Bellevue Hospital Center. Following this, he completed a fellowship in Vascular and Interventional Radiology at Thomas Jefferson University Hospital in Philadelphia, PA. Dr. Klein has been on staff at Norwalk Hospital since 2001.



Stephen Spader, RT

Stephen Spader, RT is Chief Technologist at Norwalk Radiology and Mammography Center.

About the facility

Since 1985, Norwalk Radiology & Mammography Center has grown into the largest imaging center in Fairfield County. Its expertise is in cutting-edge technology, with a commitment to providing patients with professional, concerned radiologists, highly trained technologists, helpful support staff, and—most of all—individualized care.

Norwalk Radiology & Mammography Center is fully accredited by the American College of Radiology in CT, mammography, MRI, stereotactic breast biopsy, ultrasound-guided breast biopsy, and ultrasound, and certified by the Federal Drug Administration in mammography.

> "Inhance Inflow IR is a very valuable technique. We are able to offer studies to patients who, in other circumstances, could not receive contrast and therefore, could not receive the study. It is exciting that we have something new to offer area referrals."
>
> *Linda Richardson*

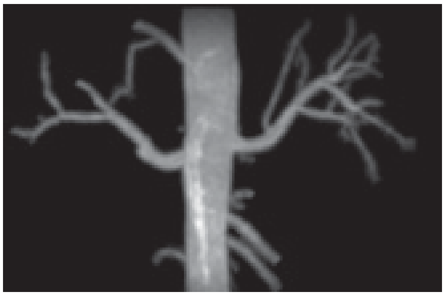


Figure 2. Diagnosis of normal renal arteries using Inhance Inflow IR.

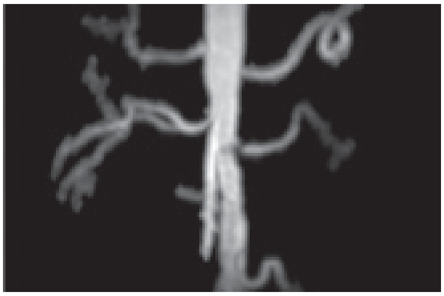
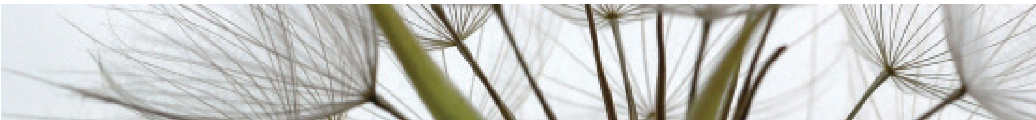


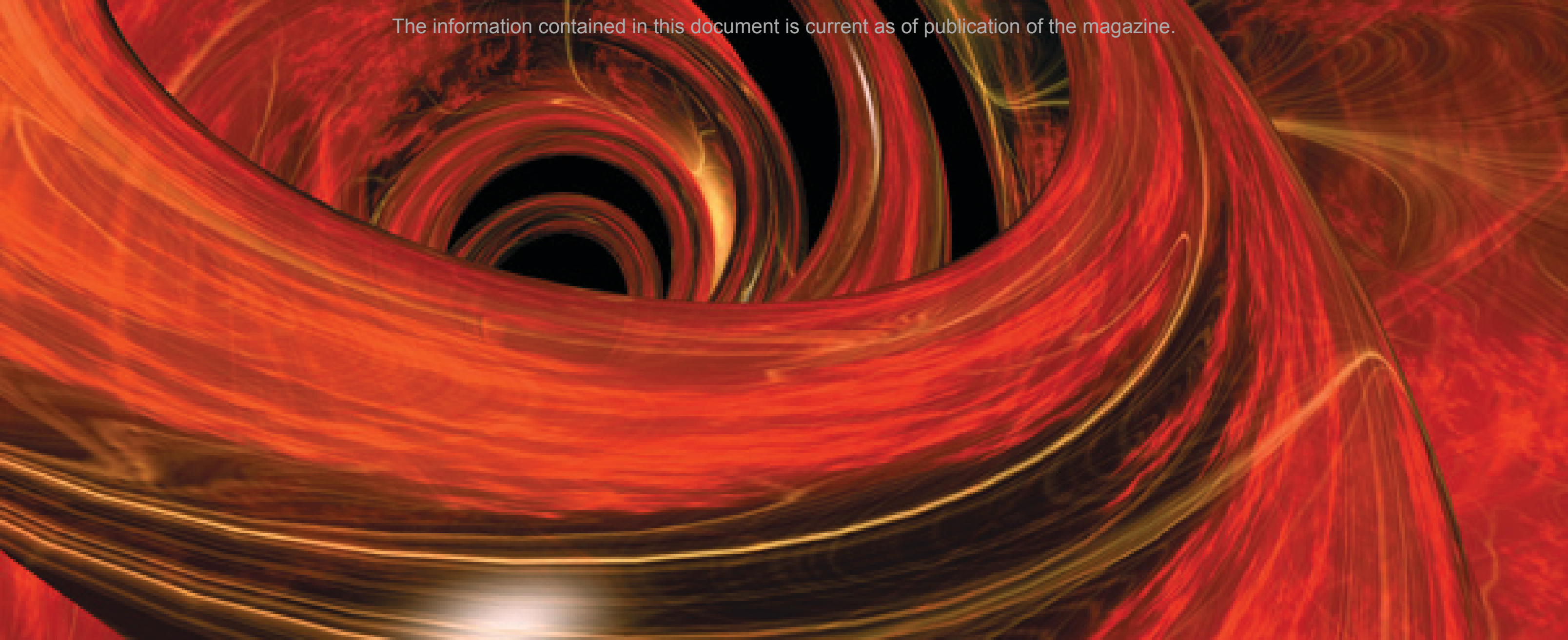
Figure 3. Inhance Inflow IR study demonstrates left main renal artery origin high grade stenosis; right main renal artery origin mild stenosis.

"Inhance Inflow IR is a breakthrough," adds Dr. Klein, "and it can be a very good marketing opportunity for a radiology practice or hospital, especially if no one else in the area can offer what is really a value-added service. It is not going to fill a magnet, but it should increase patient volume."

Norwalk has done just that. Dr. Klein and Kymberly Kittridge, Director of Marketing at Norwalk, reached out to nephrologists and internal medicine physicians to explain the new renal imaging without contrast capability. With Inhance Inflow IR as a significant market differentiator, Norwalk has gone beyond traditional boundaries and promoted it to other local competitive markets with much success.

Dr. Klein not only discussed Inhance Inflow IR with referring physicians, but also sent them key images from exams to demonstrate its capabilities. He notes that "referrers appreciate the phone call and are impressed by the ease of the imaging. Inhance Inflow IR may even become the noninvasive imaging standard for renal imaging." ■





The Best of Both Worlds

Non-contrast perfusion studies with high SNR and dynamic range, no permeability effects

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

Prior to perfusion imaging, the evaluation of primary brain tumors with MRI was somewhat limited. T2 changes don't fully depict the extent and character of lesions, while contrast enhancement does not fully reveal the extent of higher grade lesions and may be absent in lower grade lesions.

The advent of perfusion imaging—both first pass echo planar perfusion imaging and dynamic contrast imaging—brought advancements in the form of unique and powerful information to neuro imaging. However, each technique has challenges.

Echo planar dynamic susceptibility contrast (DSC) enhanced imaging is prone to artifacts, particularly near the skull base or in the brain/bone air interface especially at 3.0T where susceptibility issues are more prominent. DSC perfusion imaging can give erroneous results due to permeability effects in the presence of enhancement. For example, lesions may factitiously appear as if they have high perfusion. Dynamic contrast enhanced (DCE) T1 weighted studies attempt to correct for leakage, adding specificity but requiring an additional five minute scan.

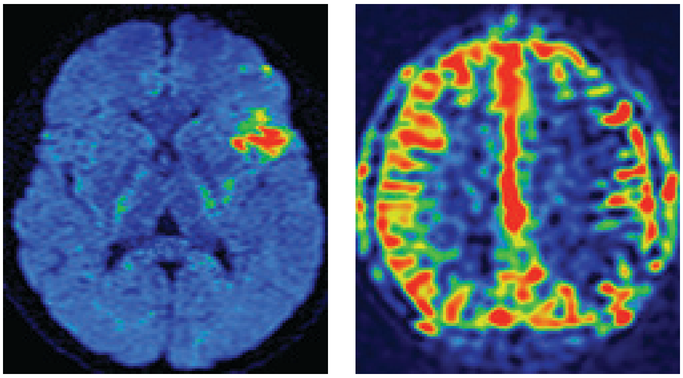
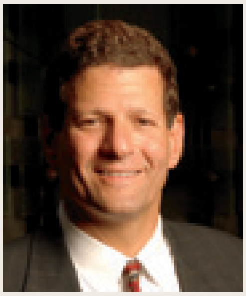


Figure 1. Large mismatch between the DWI depiction of infarction (left) and the ASL depiction of ischemia.



Dr. Lawrence N. Tanenbaum, FACR

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

About the facility

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

A new perfusion imaging technique, 3D Arterial Spin Labeling (ASL), is a fast spin echo technique that offers several advantages. The technique has a very high signal-to-noise and greater dynamic range than that of DSC.[1]

When compared to echo planar technique, 3D ASL offers an inherent resistance to susceptibility artifacts. With a skull base meningioma or a convexity mass, I can now obtain high quality perfusion information.

The images are very pleasing to the eye and easy to interpret, and no post processing is required. 3D ASL emulates the best of dynamic susceptibility contrast studies, but avoids permeability effects, allowing us to improve clinical efficiency by avoiding a five minute permeability scan. ASL provides an option for patients who historically could not receive a perfusion study due to marginal renal status or poor IV access, such as the elderly and pediatric population.

In our practice, we now routinely employ 3D ASL for imaging primary brain tumors to assist in delineating lesion presence and extent. We have utilized 3D ASL in well over 100 cases to differentiate treatment-related changes, such as scarring, radiation necrosis, and pseudo progression from residual or recurrent tumor.

Adding an advanced capability offers the potential opportunity to expand referrals. Our referring clinicians know that we employ a wide range of advanced and novel techniques such as 3D ASL to assist in answering their key clinical questions. ■

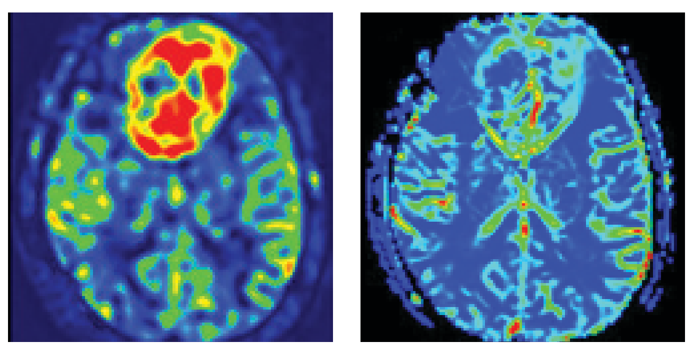


Figure 2. Patient with glioblastoma. Note the superior rendering of CBF with ASL (left) compared to DSC-CBF.

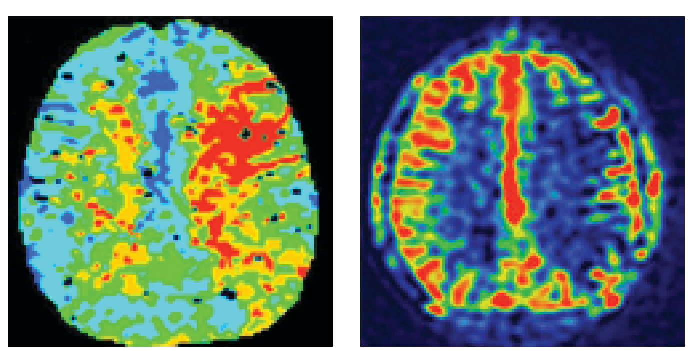


Figure 3. Comparison of time to peak (left) and ASL (right) highlights the concordance of the delayed tag arrival on ASL with arrival of the bolus of contrast with DSC.

Reference:

1. Velayudan V, Tanenbaum LN, et al. Arterial Spin Labeling Perfusion Imaging Outperforms Dynamic Susceptibility Contrast Perfusion Imaging in the Surveillance of Brain Neoplasm. American Society of Neuroradiology 2010 annual meeting. Boston, MA. May 2010

High-Performance Body MR Imaging at 3.0T

An evaluation of the Discovery† MR750 in clinical practice

By Takayuki Masui, MD, PhD, Chief of the Department of Radiology, Associate Director, Health Information Center, and Director, PET Center, Seirei Hamamatsu General Hospital

High demand for body MR imaging has coexisted with the recognition of the clinical importance of MR imaging information. The clinical introduction of 3.0T MR has increased our expectation for new and more-detailed information based on the inherent higher signal to noise ratio (SNR) at higher field strengths. However, clinical utility requires high throughput of patients for body MR studies. Thus, superiority and stability of the image quality and robustness for any type of body imaging study, regardless of the patients' body habitus, are essential at 3.0T.

The Discovery† MR750 3.0T magnet appears to satisfy these requirements due to three important features:

1. High homogeneity of the static (B0) and radiofrequency (B1) field;
2. Availability of a 32 channel body array coil with the use of parallel imaging techniques, such as Autocalibrating Reconstruction for Cartesian imaging (ARC); and
3. A wide selection of available sequences, including LAVA Flex, IDEAL, and Cube, etc.

With B0 and B1 homogeneity, credibility of body MR imaging at 3.0T is preserved with optimal contrast on standard breath-held T1-weighted images, T2-weighted images and diffusion weighted images (DWI), which can be obtained with respiratory triggering or navigator (Figures). The clinical availability of a 32 body phased array coil further enhances SNR on all body imaging studies conducted on the Discovery MR750 3.0T. Plus, a higher SNR at 3.0T using the 32 channel body array coil facilitates feasibility of higher acceleration factors for parallel imaging, such as ARC.

The availability of useful sequences such as LAVA Flex, which generates in-phase, out-of-phase, fat, and water images with one acquisition, further enhances the clinical utility of the Discovery MR750 3.0T. LAVA Flex can be utilized as a standard sequence for static as well as dynamic contrast T1w in the body. Stable low signal intensity for the fat tissue is obtained on the water images and reliable evaluation of the enhancement after administration of the Gd-chelate (contrast) can be made.

Case presentation

In hepatic imaging using Gd-EOB-DTPA, LAVA Flex water images demonstrate markedly enhanced lesions in the early dynamic phase and as low signal intensity areas in the hepatocyte phase (Figure 1). Water images demonstrate homogenous signal distributions and respiratory triggered T2WI with chemical fat saturation along with DWI clearly show lesions as high signal intensity areas with homogenous signal intensity throughout the field of view (Figure 1). DWI also provides anatomical information due to high SNR. Homogenous signal distribution can be recognized on dynamic contrast coronal water images (Figure 2). There is no distortion at the corner of the image (Figures 2, 3).

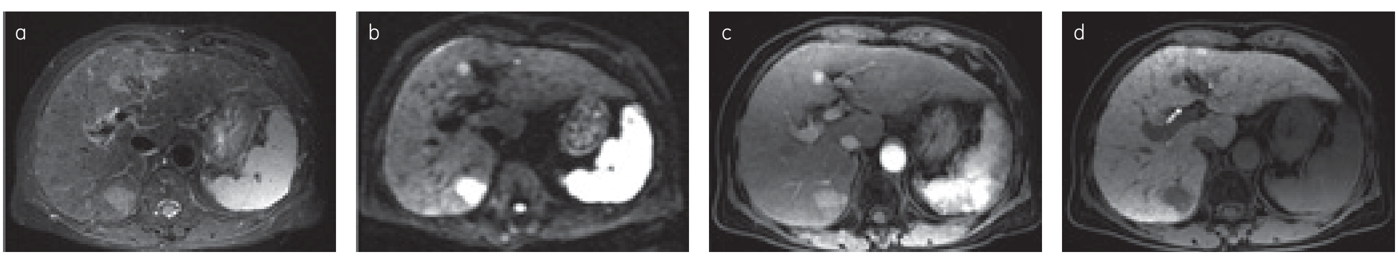


Figure 1. Hepatocellular carcinoma, Liver cirrhosis. All water images generated with LAVA Flex. (a) Respiratory triggered fat sat T2WI. (b) Respiratory triggered DWI (b-value 800 s/mm^2). (c) Breath-held Gd-EOB-DTPA enhanced water image in arterial phase with Smart prep. (d) Breath-held Gd-EOB-DTPA enhanced water image in hepatocyte phase.

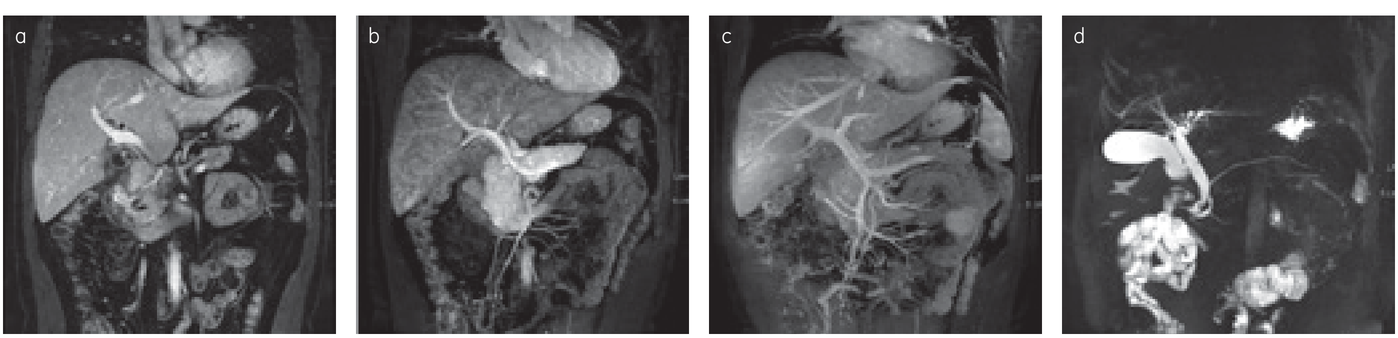
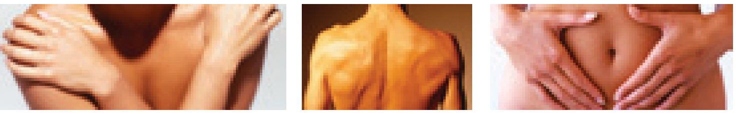


Figure 2. Adenoma of major duodenal papilla. All water images generated with LAVA Flex. (a) Breath-held contrast enhanced water image in arterial phase with Smart prep. (b) Breath-held contrast enhanced water image with partial MIP. (c) Breath-held contrast enhanced water image in portal phase with MIP. (d) Respiratory triggered 3D FSE MRCP with MI.



With improvements of B0 and B1 homogeneity, signal intensity of the water, such as urine in the urinary bladder, shows homogenous high signal intensity on T2WI (Figure 4). On DWI, tumors in the urinary bladder can be recognized as high signal intensity with inhomogeneity due to susceptibility by the hemorrhage in the tumor (Figure 4).

In summary, clinical body MR imaging at 3.0T provides credible quality images and enables high patient throughput due to the robustness of studies through improvements of B0 and B1 homogeneity, high SNR, a 32 channel coil, and a wide variety of clinically useful sequences. ■

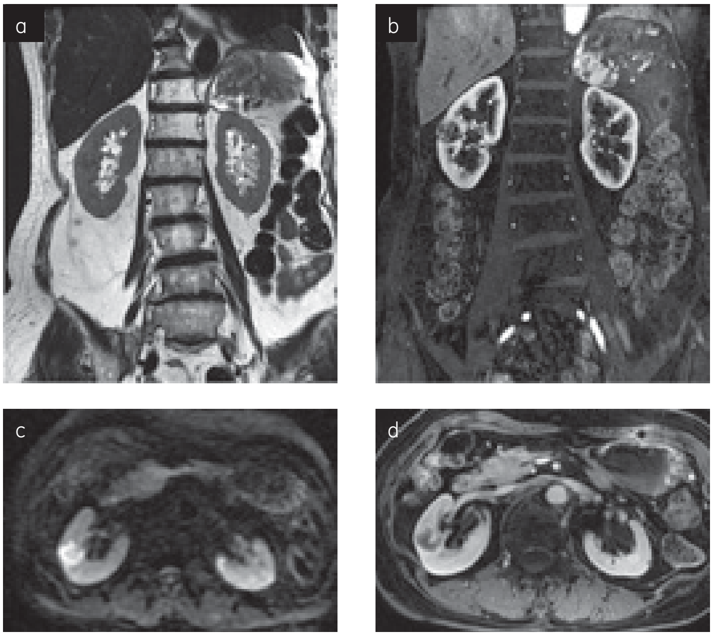


Figure 3. Renal metastasis from rectal cancer. All water images generated with LAVA Flex. (a) Breath-held coronal T2WI. (b) Breath-held Dynamic contrast enhanced water image with Smart prep. (c) Respiratory triggered DWI (b-value 800 s/mm^2). (d) Breath-held contrast enhanced water image.

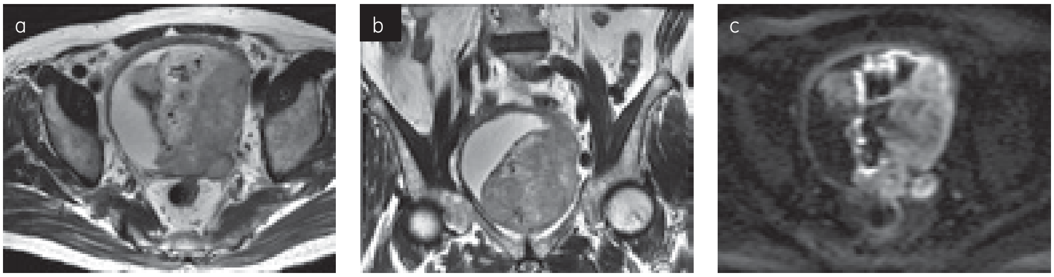


Figure 4. Urinary bladder cancer. (a) Transverse T2WI. (b) Coronal T2WI. (c) DWI (b-value 1500 s/mm^2).

Dr. Takayuki Masui

Takayuki Masui, MD, PhD, is Chief of the Department of Radiology, Associate Director, Health Information Center and Director, PET Center at 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, vascular MR, and CT.

About the facility

Seirei Hamamatsu General Hospital is one of the core hospitals of Seirei Social Welfare Community, Japan's largest community established in 1930. Seirei offers more than 100 facilities and 200 services throughout Japan, including five major hospitals, two medical check-up facilities and seven clinics. The 744-bed Seirei Hamamatsu General Hospital is located between Tokyo and Kyoto. More than 1,700 active medical staff provide healthcare to 1,750 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 was awarded with the Healthcare Quality Encouragement.

Diagnostic Center in Germany

Experiences Increased Productivity, Workflow After Integrating New MR System

Radiology Institute and Breast Diagnostic Center, East Nuernberg Campus, is first in world to bring Optima† MR360 1.5T* into daily practice

In a new diagnostic center in Nuernberg, Germany the bright lights and smiling faces mask the pressure felt by MR staff and patients. Worry can be a typical emotion felt by patients—what will the results be? Is the exam going to hurt? Additionally, the sights and sounds of the mysterious-looking machines in the exam rooms can make some soon-to-be scanned patients feel anxious.

Meanwhile, the staff puts on its best face while trying to keep pace with an unrelenting exam schedule. It's crucial to not overlook a single detail that may prove critical for the patient's exam, the radiologist's requirements, or the exacting demands of a highly technical diagnostic sequence.

*At the time of printing, the Optima MR360 system is not approved or cleared by the U.S. Food and Drug Administration (FDA) and is not available in the USA.

Figure 1a and 1b. Reformat of Cube PD FS using the Quadknee coil with no parallel imaging (ARC). Real isotropic 0.8 x 0.8 x 0.8 mm, 272 slices in 5.33 min. fulfills German guidelines.

Figure 1c. Cube T2 reformat of the ACL using Quadknee coil.

Yet a few minutes later, everyone is smiling genuinely—thanks to another spectacular performance by the versatile Optima MR360 1.5T*. "Danke schön! Ja, vielen Dank! Auf Wiedersehen!" With the exam successfully completed, the patient is already heading for home—even as the technician prepares for the next exam.

Such moments have become routine at the Radiology Institute and Breast Diagnostic Center, East Nuernberg Campus. The facility in Nuernberg, Germany opened in July, 2010 as the first diagnostic center in the world to bring the Optima MR360 1.5T from GE Healthcare into daily practice. The modern center is part of a cooperative practice that groups 300 independent radiologists with a sustained focus on achieving cost savings while responding to a persistent professional pressure to meet ever-increasing standards for quality imaging.

Performing under pressure

In planning the new facility, Hubertus Gloger, MD, Radiologist, projected a daily average of 30 patients across a full range of MR examinations including abdominal, head and neck, extremities, breast, and cardiac. The demand for versatility in a new scanner was matched by a requirement for a simplified workflow that would assure the higher productivity necessary to meet the goal of increasing access for the greatest number of patients.

These performance objectives became more critical in the larger context of Germany's drive for savings for the national health insurance fund.

"The ultra-modern Optima MR360 makes it possible for us to conduct a wide range of flexible and efficient MR examinations," explains Dr. Gloger. "Thanks to the time-saving recording techniques as well as simplified workflows, we hope to examine patients in a shorter time. Our objective is for more people to benefit from a best possible diagnostic examination. In addition, the new system consumes less energy and has a sustainable technology."

Intuitive and automatic work routines

It took just two days for the technical staff to become fast friends with the newly installed Optima MR360. According to Dr. Gloger, work routines were surprisingly simplified, intuitive and automated, and the technicians were really enthusiastic about working with the system.

"They accepted the new hardware and software features very quickly. We started planning exams right away with no wasted time for set ups, and no unnecessary waiting—neither for the staff nor for the patients," adds Dr. Gloger. "By just the second day of operation we were able to increase patient throughput."

Key Performance Indicators

Just months after integrating the new Optima MR360 1.5T, the partner physicians of the Nuernberg facility are already looking to further expand capabilities with new MR systems from GE Healthcare. Here's why:

- The Optima MR360 1.5T packs a lot of performance within a space-saving profile, and steps lightly with a remarkably reduced footprint for operating costs and environmental impact.
- The radiologists singled out the "perfect service" of the GE Healthcare team with a same-day response to questions as a critical factor in the decision to continue building on what they called a "foundation of trust."
- Application rich, the Optix RF transmission technology of the Optima MR360 met the requirements of the Nuernberg radiologists for reliable picture quality and robust performance. For example, 3D Cube, 3D VIBRANT and 3D LAVA responded to the center's increasing need for image reconstruction in three dimensions that allow the radiologists to examine lesions in volume—whether for difficult anatomies of muscular skeletal structures, or for soft tissue of the brain, abdomen or breast. The Optima MR360 capability to acquire 3D datasets in a single scan results in significant time savings.

Ecomagination certified, the Optima MR360 is a "sustainable technology," according to Dr. Gloger.

Familiar with the user interface from a GE Healthcare MR system used at the previous facility, the technical staff appreciated the Ready Interface on the Optima MR360 control center, which requires fewer steps to optimize scan parameters. The system also offers Intuitive Shortcuts, enabling users to easily access their most common protocols; the Ready Bar Control, which reduces 30 inputs with a single control—simplifying scan optimization while experienced users maintain full control of all parameters; and READYBrain—a new acquisition technique that automatically determines slice alignment for brain scans.

"We were able to use the Optima system right from the start," says technician Renate Sharper. "It has fewer buttons and takes fewer mouse clicks, and exam series are automatically linked so when we carry out a T1 exam with specific

Figure 2. (left) Axial T2 FRFSE pelvis 4mm 512 x 256; (middle) Sag T2 FRFSE T-spine 512 x 256 2 min, 37 s; (right) Sagittal T2 FRFSE HR L-spine 512 x 320

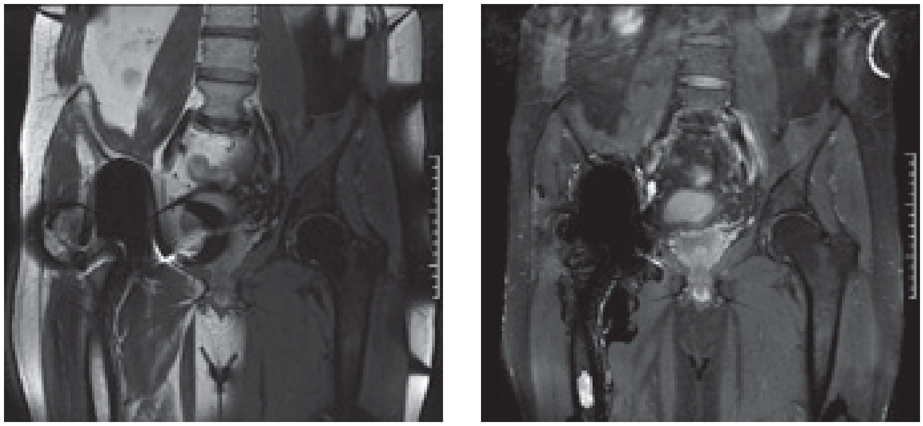


Figure 3. Patient with metal in hips; PD FS (left) PD IDEAL water (right).

parameters, the following T2 exam will be performed using the exact same parameters and slice localizations. This influences the whole process, from acquisition to post processing."

Express Coil—making life easier

Sharper reserves her most enthusiastic comments for the Express Coil, which is embedded in the examination table for scans of head, neck, abdomen and spine, and eliminates the need to reposition patients.

"What is really great is not having to carry a heavy coil for setting up the exam, and then not having to move the patient during the exam—both of which can be a lot of work," says Sharper. "It just makes the job that much easier."

After several months working with this unique feature on the Optima MR360, Sharper reports, "We are experimenting with different possibilities to find the right patient flow. For example, scheduling knee exams in the morning and then back exams in the afternoon creates a win-win situation for patients and staff. Quicker exams mean the patients do not have to wait, and it makes the entire process easier for us as well."

The new Optima MR360 is well suited for a wide range of MR scanning needs—with the ease of operation to help make a clinician's staff more productive. For streamlining routine scans, the system incorporates an express exam approach to MR. It includes many intuitive and automated functions that help increase patient comfort, operator confidence, image consistency, and professional satisfaction of MR staff. ■

The team at the Radiology Institute, Nuernberg, with the new Optima MR360 1.5T. From left to right: Olena Schubert, Dr. Anita Zajdler, Dr. Klaus Gentes, Dr. Oleg Cherevatyy, Dr. Hubertus Gloger, Dr. Norbert Wilke.

Stretch Your Budget, Not Your Staff

An application-rich, 1.5T MR system, the Optima† MR360* from GE Healthcare can improve your imaging productivity while lowering your ownership costs. By combining uncompromised image quality and versatility with the ongoing benefits of an ecomagination product, it provides you with outstanding MR imaging value.

We'll let you see for yourself!

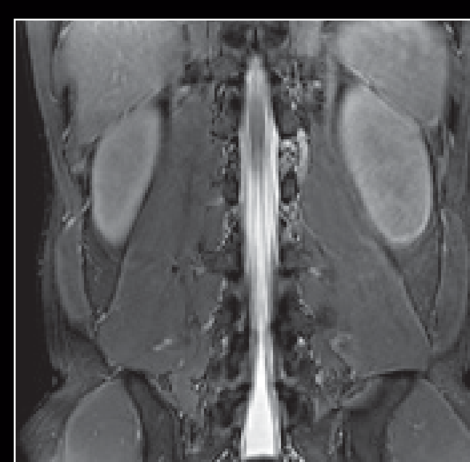
Body

3D Dual Echo
Enables capture of in-phase and out-of-phase imaging in a single breathhold.

Vascular

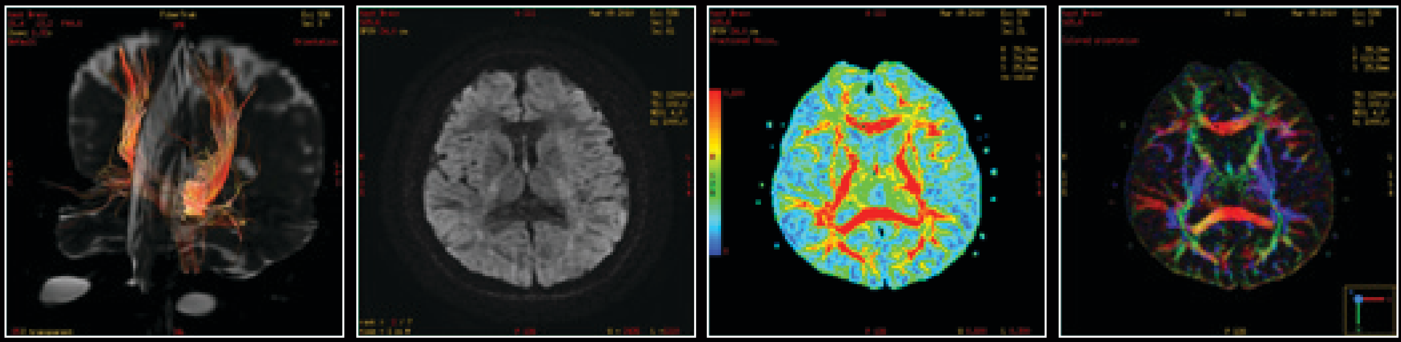
Inhance Inflow IR. Non-contrast, respiratory triggered acquisition, revealing fine detail in distal vasculature.

Spine



Coronal FIESTA detailing nerve roots into the lumbar spine.

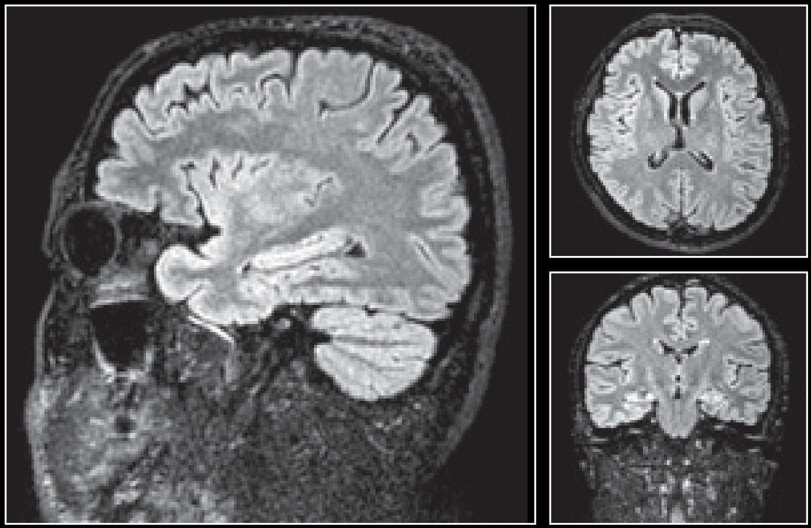
*At the time of printing, the Optima MR360 system is not approved or cleared by the U.S. Food and Drug Administration (FDA) and is not available in the USA.



DTI and FiberTrak

Optima MR360 delivers uncompromised, high-resolution, 64-direction diffusion tensor images. DTI/ FiberTrak visualizes white matter trajectories in the brain and generates directional FA maps, as well as 3D white matter projections. The strong gradient performance of the Optima MR360 enables the ability to capture exquisite DTI outputs.

Brain



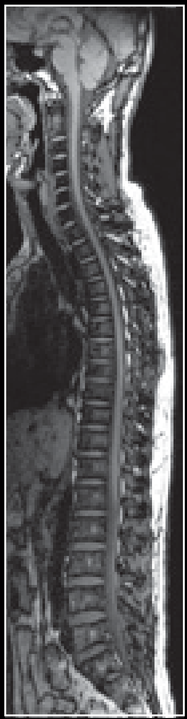
Cube is a volumetric imaging technique with isotropic voxels—scan once and reformat into any plane with excellent resolution. Cube deploys ARC acceleration, which enables small voxel size without expanding exam time. Cube is compatible with multiple contrasts. T2 FLAIR shown.

IAC image visualizing 7th and 8th nerve routes.

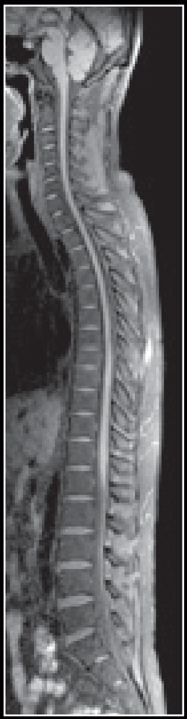
Express Coil

IDEAL fat only.

IDEAL in-phase.

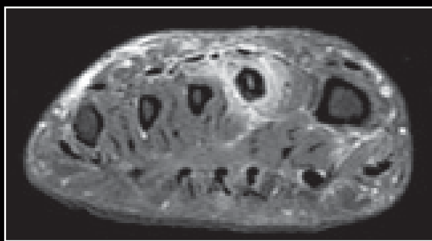


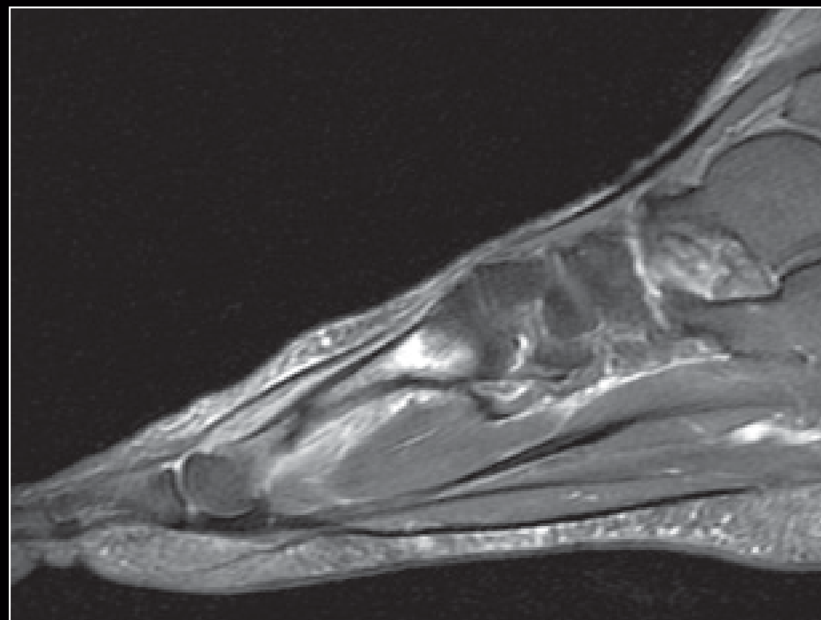
IDEAL out-of-phase.



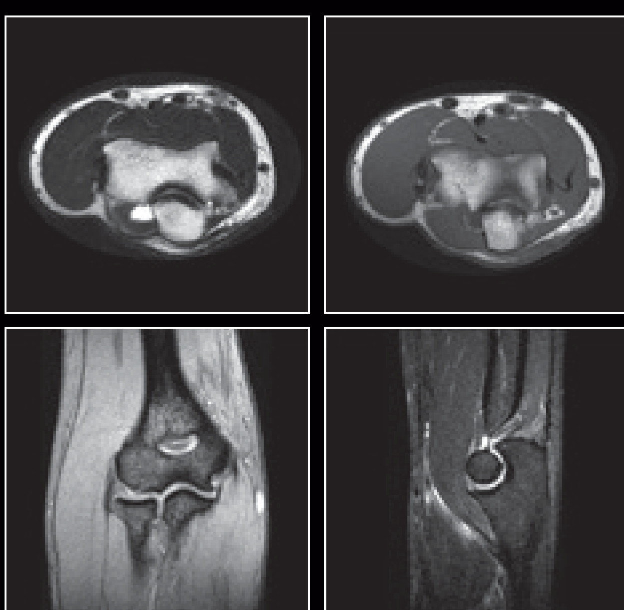
IDEAL water only.

MSK

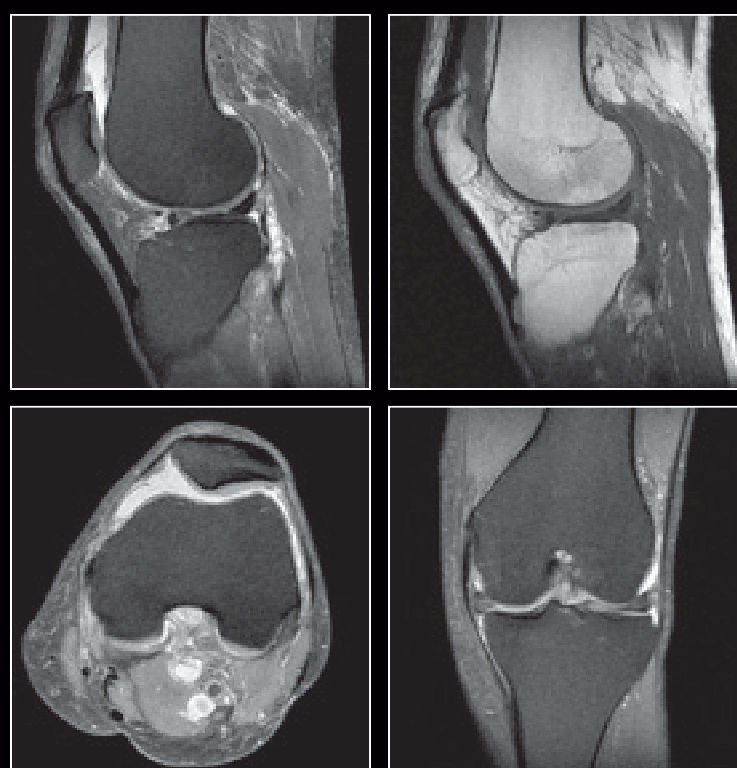




Foot imaging demonstrating uniform fat suppression throughout the image. Suspected fracture of second metatarcel.



Elbow exam.



High resolution knee case using the quadrature extremity coil.

GE Healthcare extends its gratitude to PLA Hospital #301 (Beijing, China), Platinum Imaging Center (New Delhi, India), Yatsuo Sogo Hospital (Toyoma, Japan), and the Radiology Institute and Breast Diagnostic Center, East Nuernberg Campus (Nuernberg, Germany) for contributing the Optima MR360 1.5T clinical cases featured in this article. System is not approved or cleared by the U.S. Food and Drug Administration (FDA) and is not available in the USA.

Simplifying the Complex: New User Interface Offers Heightened Efficiency, System Performance, Patient Care

Brivo† MR355, Optima† MR360 systems aim to increase accessibility of MR worldwide

By Antoine Choppin, Software Architect, Hino MR Engineering, GE Healthcare Japan

Can an MR scanner be as easy to operate as taking a picture with just one click? How could we simplify the MR user interface yet retain the power and flexibility of today's advanced MR scanners? These questions formed the premise of our development of the new Ready Interface for the Brivo MR355* and Optima MR360* MR imaging systems from GE Healthcare.

MR scanners are complex machines, involving the tuning of multiple parameters that can influence image quality and/or scan time. However, personnel rotation and multi-disciplinary teams may often lead to new or less-experienced technologists operating an MR scanner. On the other hand, experienced technologists and physicians do not want to compromise on image quality and, therefore, prefer to keep control over all imaging parameters. Regardless of the level of experience, all operators prefer to eliminate repetitive tasks so they can focus on efficiency, system performance, and patient care.

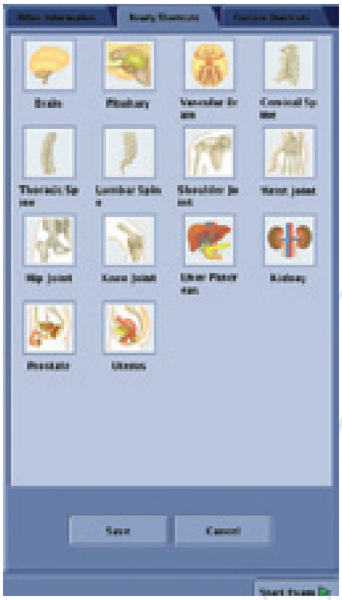


Figure 1. Ready Shortcuts

*At the time of printing, the Brivo MR355 and Optima MR360 systems are not approved or cleared by the U.S. Food and Drug Administration (FDA) and are not available in the USA.

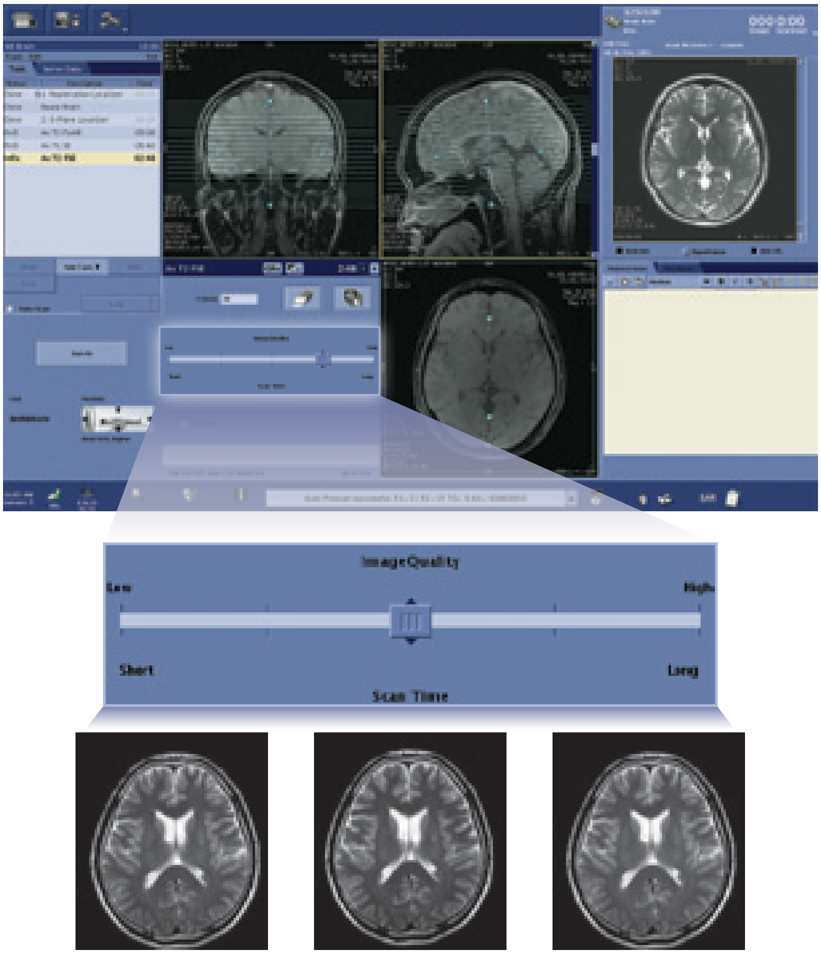
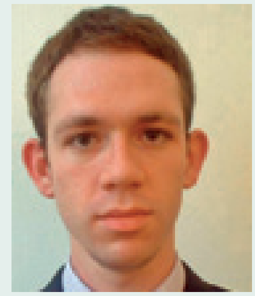


Figure 2. Simple UI mode, Coil Auto Selection, and Ready Bar



Antoine Choppin

The dichotomy of fulfilling the needs of novice and advanced users led us to consider building a new user interface from the ground up. However, we did not want to take a step back in product development. So, we decided to start with the Discovery† MR750 user interface for its optimized work-flow management but reduce its complexity for easier operation by inexperienced users. Starting a new study had to be straight forward, so we developed icons for the most used protocols. A single mouse click launches the new "Ready Shortcuts" while the "Simple UI" mode displays only the key parameters for routine scans. Experienced operators can easily switch from "Standard" to "Advanced" modes when necessary (Figure 1), although our goal was to enable the user to operate routine scans in the "Standard" mode.

For instance, the "Auto TR" feature automatically adjusts TR to optimize scan time when the number of slices varies, while preserving image contrast. Another feature, "Automatic Coil Selection," allows the user to automatically select optimal coil elements in real time to maximize SNR for each scan. With these features, extra tuning becomes unnecessary and brings us closer to a "one touch scan" user interface.

What if the operator suddenly wishes to reduce scan time (e.g. when a child or elder is lying on the table) or the physician requests higher image quality? While experienced users would quickly adjust one or more parameters to fulfill these needs, less-experienced technologists may struggle with these tasks. To help resolve the issue, we designed the "Ready Bar," a simple slider bar that allows the user to tune a protocol, reduce scan time or increase image quality in real time (Figure 2). The flexibility of this feature will also help more advanced operators focus on efficiency, patient care, and scan quality.

The new Ready Interface, designed to simplify operation in even the most demanding or complex exams, is available with the Brivo MR355 and Optima MR360 MR systems. It is our hope that these easier to use MR systems will increase the accessibility of MR around the world and help contribute to keeping more people healthy. ■

READYBrain offers automated prescription of brain exams quickly and consistently

MR Efficiency Becomes Critical as Healthcare Costs, Scanner Time Demand Increases

By Katie McMillan, Mitsuhiro Uike, Xiaodong Tao, Susumu Kosugi, and Hirohito Okuda, GE Healthcare

An MRI examination of the brain consists of a number of connected steps ranging from settling the patient on the table to transferring the final image data to a reading station. These steps can vary by institution, user, and type of exam such that the workflow is optimized for a given situation.

As healthcare costs rise and demand of scanner time increases, efficiency within MR has become more important to healthcare institutions. Answering this need is the Express Exam, a new solution from GE Healthcare that automates routine steps in a comprehensive brain exam. A key element of the Express Exam is READYBrain*, which enables users to quickly obtain consistent results via guidance of prescriptions across patient studies.

*At the time of printing, READYBrain is not approved or cleared by the U.S. Food and Drug Administration (FDA) and is not available in the USA.

Registration

The Registration Localizer is located in the READYBrain protocol and consists of an axial acquisition based on standard distances from the technologist-placed landmark, typically placed at the nasion. Additional slices have been added to account for slight differences in landmark position preference so that the entire head is covered.

This localizer is a fast spoiled gradient echo (FSPGR) sequence (TR/TE 5.7/1.2 ms, flip 11, matrix 112x112, FOV 28 cm, slice thickness 3 mm, 64 slices).

Computation of ready scan planes

Based on the Registration Localizer, a computation step is initiated to calculate the prescription plane.

1. Detect the top of the head via a signal intensity analysis.
2. Detect inter-hemispheric fissure using a 2D line-projection of the axial images and detecting the minima using an axial image. This enables the correction of large rotations and reduces sensitivity to brain asymmetry due to anatomy or pathology.
3. Mid-sagittal plane detection based on mutual information registration, i.e., a 3D rigid transform is represented with six degrees of freedom (rotation = cos-1(w); translation = tx, ty, tz).
   a. 3D image set (Figure 1a) is flipped left-right around the central hemispheric fissure axis (as detected in step 2 and shown in Figure 1b); the transformation to align the original image to its flipped version via a mutual information-based metric is calculated. The 3D rigid transform can be represented as a quaternion, Q = [x,y,z,w] where x2+y2+z2+w2=1.

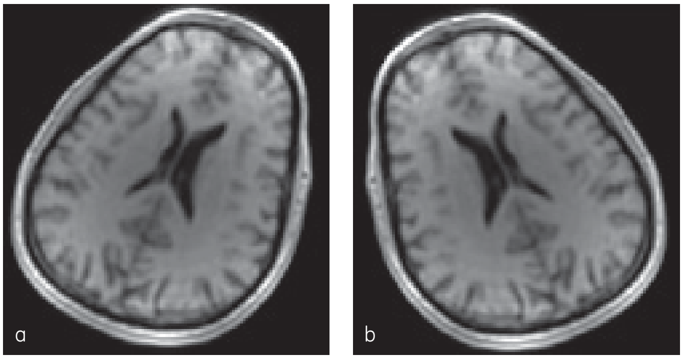


Figure 1.

   b. This transform is halved based on the assumption that neuro-anatomy is largely symmetric, so that Q1/2 = [x/a, y/a, z/a, a/4], where a = sqrt(2(1+w)). Application of this transform creates an aligned subject image (Figure 2a), with a corresponding mid-sagittal plane, (Figure 2b).

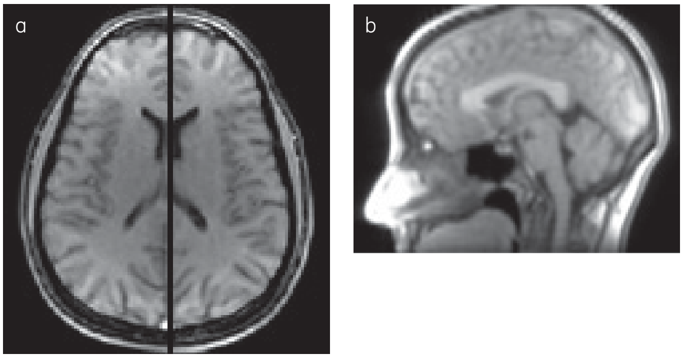


Figure 2.

4. 2D registration of mid-sagittal plane (Figure 2b) to a reference image (Figure 3a) based on 2D rigid (x,y translation and rotation). The reference image is considered to be ground truth given its expert prescription by a trained radiologist and scaling is applied to account for size variances across patients.

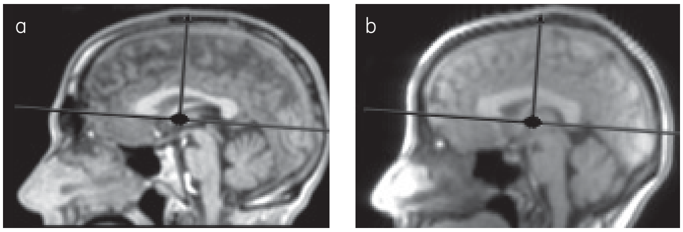


Figure 3.

5. Ready planes are translated from the reference to patient image based on the 3D transform computed in step 3 and the 2D transform calculated in step 4, resulting in the Ready scan planes applied to the patient being scanned (Figure 3b).

This five-step calculation takes 20 to 30 seconds.

Application and revision

Ready scan planes can be found in the drop-down menu on the user interface for subsequent series in the Ready exam (Figure 4).

The READYBrain calculation (see ● in Figure 4) is employed as an automatic processing step immediately after the acquisition of the Registration Localizer completes.

Ready scan planes can be applied via the linking process (see □ in Figure 4). GE applications specialists can assist users in defining the optimal protocols for each institution. When linking is properly used, altering the angle of the Ready plane within the Graphic Prescription window will propagate to future series in the exam. It is important to note that from a consistency perspective in longitudinal exams, these user-defined changes will be lost.

Express exam

There are several workflow tools inherent to the Discovery† and Optima† platforms that increase efficiency and reliability. When these are combined with READYBrain, the result is a more seamless experience for patients and users. The tools include:

- Auto Start—When protocols are properly set before entering the exam room with a new patient, the Localizer will begin upon closing the door. Auto Start is found on the prescription page under the worklist.
- Linking—Series within protocols can be paired so that certain scan parameters (field of view, prescription, shim volumes, etc.) match for future series (see □ in Figure 4).
- AutoScan—For saved scans, the subsequent series will begin to acquire image data upon the completion of the previous series (see ♦ in Figure 4).
- In-line processing—Post-processing steps can be added to protocols for any of the following Functool calculations (see ● in Figure 4): DWI (create ADC maps), and DTI (create ADC or FA maps).

Performance

Members of GE Healthcare's engineering team in Hino, Japan worked with scientists at GE's Global Research Center (Niskayuna, NY) and members of the global MR team in Waukesha, WI, to explore the potential of workflow strategies in brain imaging.

Landmark-segmentation and volumetric-registration based algorithms were evaluated as alternate approaches. While landmark-based methods can be fast, there are reliability issues with simulations and patients with pathology. Volumetric registration-based methods offer flexibility in defining the scan plane of interest, but can vary widely based on the patient anatomy being scanned. We found limitations in reliability with this method as well.

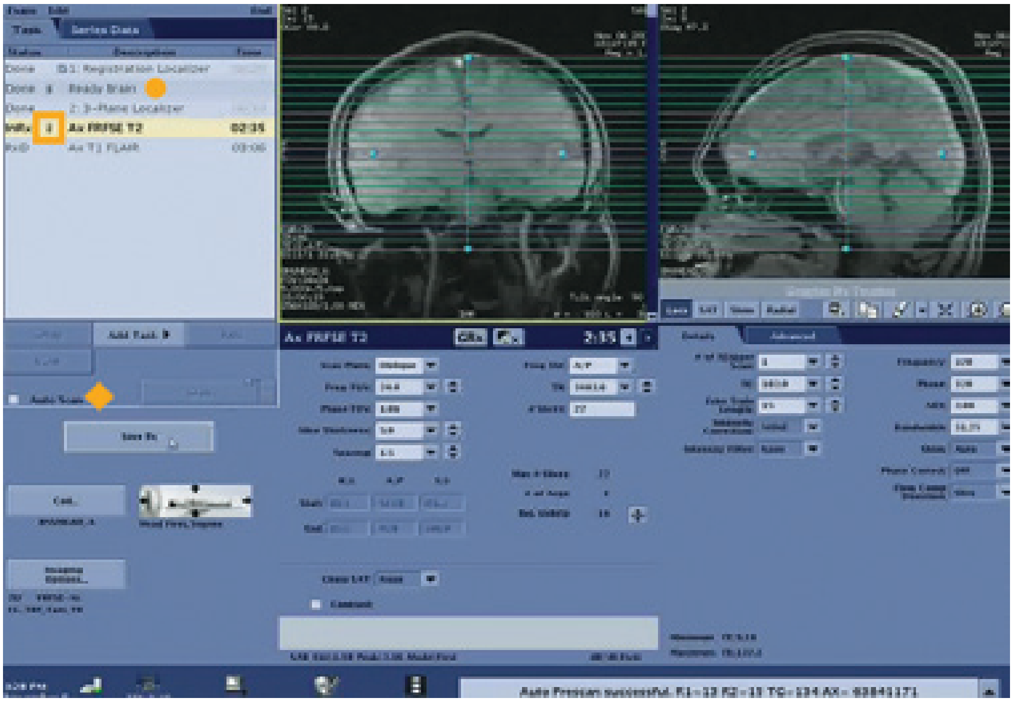


Figure 4.

The team evaluated approximately 200 cases from normal volunteers and patient data provided by research partners. Many cases contained longitudinal data in order to understand reliability and reproducibility.

However, the most compelling data came from prototype use in clinical practice at Shimane University Hospital and Sapporo University Hospital. Eighty-five cases were reported under the initial evaluation and all but one case met or exceeded the facilities' expectations of how an automatic prescription prototype should perform based on overall performance, symmetry of the automatic prescription, and the ACPC angle and position.

For formal verification of specifications, 36 cases were used to verify each of the following with 99% confidence intervals:

- Repeatability—the follow-up prescription matched the baseline data within 3.9 mm and 3.6 degrees;
- ACPC midline position matched ground truth as defined by an expert radiologist within 7.8 mm;
- ACPC angle matches ground truth as defined by an expert radiologist within 7 degrees; and
- Anterior-posterior and superior-inferior symmetry matched ground truth as defined by an expert radiologist within 2.8 degrees. ■

Results and Accuracy

Contributed by Hajime Katagaki, MD, Shiro Ozaki, RT, Koji Uchida, RT, and Shinji Hara, RT, Shimane University Hospital

Investigators at Shimane University Hospital evaluated accuracy of the AC-PC plane as determined by the READYBrain prototype and tested for differences against manual prescription. Two scans (one acquired with READYBrain and one with manual settings) were resampled to the same resolution as an SPM template and aligned with it such that three degrees of freedom (x, y, and z rotations) were calculated for both READYBrain and manual prescriptions.

Figure 5 shows that READYBrain resulted in significantly less mismatch of the AC-PC angle with the SPM2 template and a smaller standard deviation than setting slices manually when looking at the rotation in z (pitch). The investigators also found that less experienced MR operators can achieve an accurate AC-PC angle plane with READYBrain. In addition, they determined that READYBrain would be very useful for follow-up studies as it can easily reproduce the same angle as a prior exam.

About the facility

Shimane University is a regional medical center focused on clinical diagnosis and treatment as well as medical education. Their imaging equipment includes a 1.5T HDx and 3.0T HDxt system from GE Healthcare.

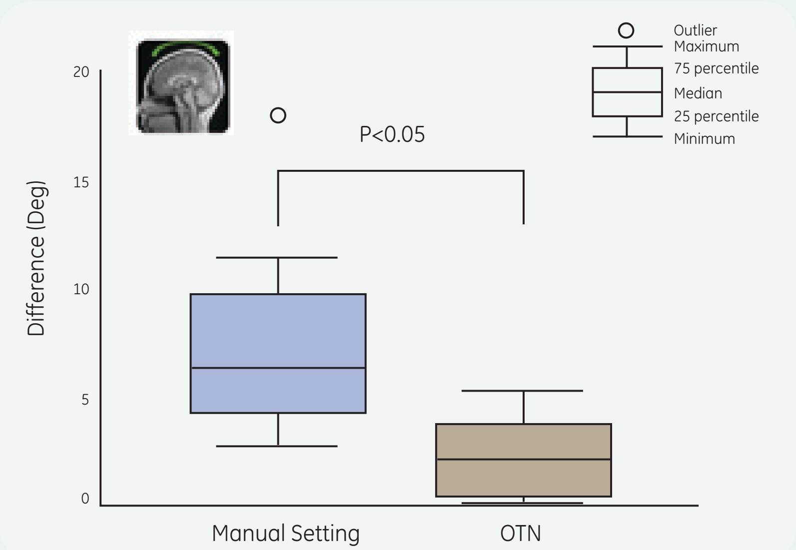


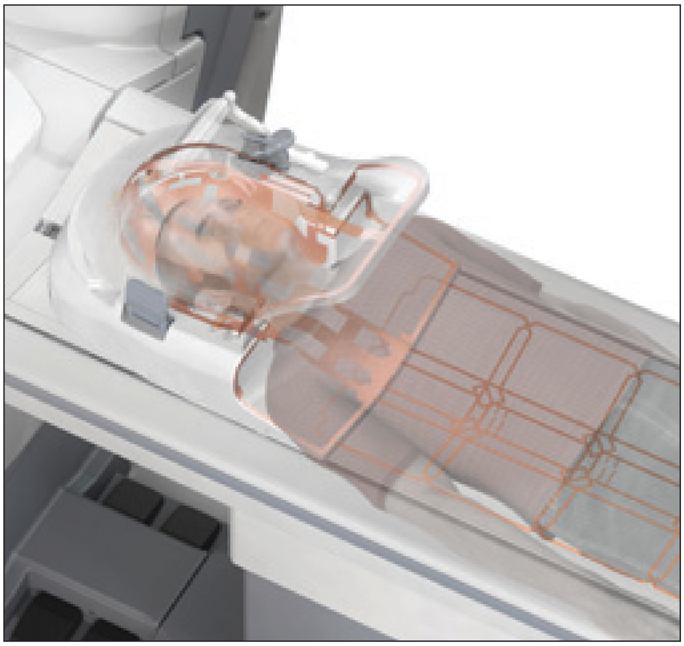
Figure 5.

Light, Affordable High-Quality Coils

By Janeiro E. Aguilar, Coil Engineer, Hino MR Engineering, GE Healthcare Japan

Operating an MRI system is often perceived as a daunting task due to the underlying physics of MR imaging mechanics and complex imaging techniques. Historically, the higher cost of MRI compared to traditional CT imaging devices has been a barrier to implementation across the world.

*At the time of printing, the Optima MR360 and Brivo MR355 systems are not approved or cleared by the U.S. Food and Drug Administration (FDA) and are not available in the USA.



Recognizing the need for an easier-to-operate MRI system, GE Healthcare introduced the Optima† MR360/ Brivo† MR355 platform.

At the heart of this platform is the new Express Coils—the first general-purpose coil suite introduced by GE Healthcare that includes an embedded coil. When used with the Optima MR360* or Brivo MR355*, the result is a less complicated MR system.

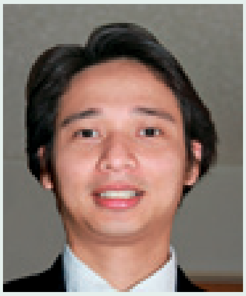
The Express Coils consist of three coils: the Head-Neck Array, the Anterior Array, and the Posterior Array. Together, they are used for approximately 70% to 90% of routine MR diagnostic imaging. Continuing the legacy of GE Healthcare coils, the Express Coils offer image quality comparable to the anatomy-dedicated coils presently available. By reducing the number of coils needed for high-quality imaging, storage space and total cost are dramatically reduced—offering the potential for higher patient throughput and comfort.

The Head-Neck Array is lighter than present alternatives, making initial coil set up easier for the technologist. Another feature is the horseshoe adapter, which allows the Head-Neck Array to be left on top of the table during spine imaging. This enhances convenience and enables the operator to increase overall throughput.

Similarly, the Anterior Array is 1.3 kg, providing the same advantages for the technologist as the Head-Neck Array. This also improves patient comfort, as he or she must bear the weight of the coil that is placed on top. Plus, throughput is positively impacted since the Anterior Array has enough coverage to scan the chest, abdomen, pelvis, and hip joint.

The Posterior Array is an embedded coil that eliminates the need for additional patient set up and positioning. Patients will find the Posterior Array very comfortable to lie on as it takes the curve shape of the cradle and does not cause unnecessary stress to the shoulder.

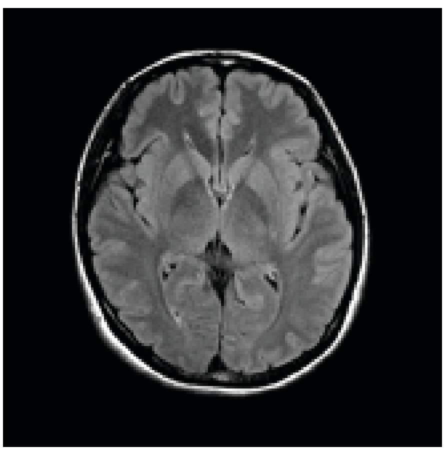
Although this coil is embedded inside the cradle, there is a minimum gap—only 8mm—between the coil elements and the patient's body to preserve a high signal-to-noise ratio. It also allows head-first, feet-first torso, and body scanning when used together with the Anterior Array. The design of the three Express Arrays allows seamless coverage of head-neck-spine-thorax-abdomen without extracting the patient.



Janeiro E. Aguilar

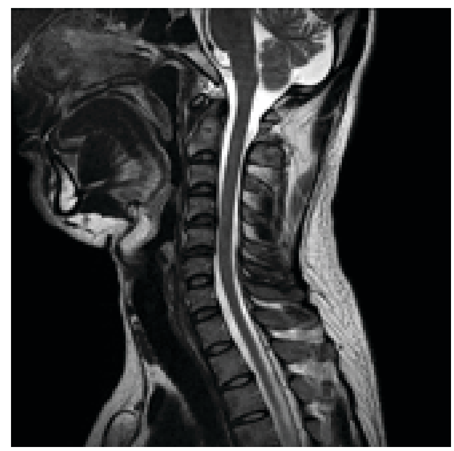
GE Healthcare also developed the Auto-Coil selection, a software feature that automatically selects and activates the appropriate element of the Express Coil suite based upon the anatomical slice drawn from the localizer.

This global coil design effort—utilizing the expertise of GE Healthcare's engineering team members in Japan, India, China, and the United States—overcame several technical challenges to develop the Express Coils. In line with the vision of healthymagination, GE Healthcare now offers a sophisticated, high-quality coil suite that is lower in cost and easier to use, making the Express Coils an excellent solution for facilities worldwide while bringing the clinical value of MR imaging within reach to people everywhere. The Express Coil Suite is another step forward to a healthier world. ■

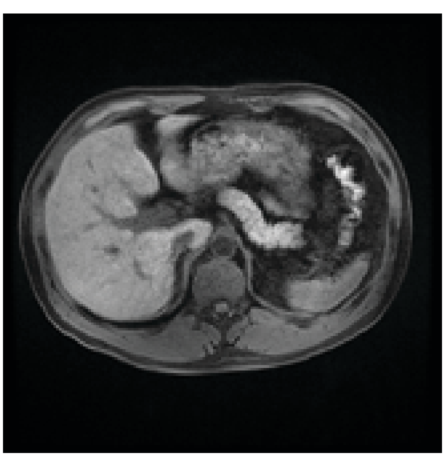


Brain Axial T2 Flair

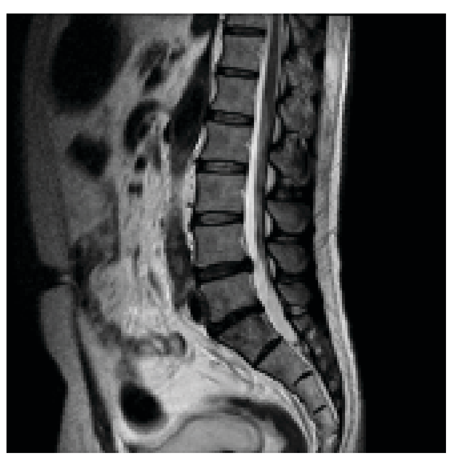
Brain Sagittal T2 Fast Spin Echo



Cervical Spine Sagittal T2 Fast Recovery Fast Spin Echo



Liver Axial LAVA in 19 sec



Lumbar Spine Sagittal T2 Fast Recovery Fast Spin Echo

Portal Vein Coronal Inhance 3D InFlow IR

Goodbye Shading, Hello Image Clarity

EllipTX technology on the Discovery MR750 3.0T virtually eliminates issues with shading in 3.0T MR body imaging.

Innovation for today and tomorrow. Engineered to unleash the power of MR. These were our promises to you with the 2008 launch of the Discovery† MR750 3.0T system.

First we gave you OpTix, a GE-exclusive Optical RF Technology that adds up to 27 percent higher signal-to-noise ratio (SNR) over conventional, non-optical MR receivers by reducing electrical noise and increasing signal detection.

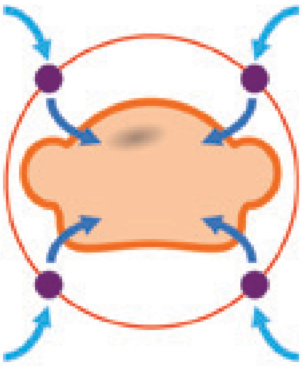
Now, we're going even further with EllipTX technology. By controlling the RF transmission across four drive ports on the RF body coil, EllipTX generates an elliptical RF field that better matches the cross-sectional shape of the body, images with EllipTX are more uniform by nearly a factor of two. What's more, this technology lets you image just the way you always have—there is no need for additional calibration scans to measure and then compensate for shading.

EllipTX constantly works in the background, helping you consistently produce exceptional chest, abdomen, pelvis, and breast images minus the shading artifacts.

Concerned about SAR? No need to worry with EllipTX—it does not negatively impact SAR and it works with the existing Discovery MR750's SAR-efficient RF body coil design. No need for a costly upgrade and system downtime.

What's more, it lets you image just the way you always have. You can improve image uniformity without the need for additional pre-scans to measure, calibrate and then compensate for shading. It's transparent to the user yet effective across a range of body types and sizes.

Are you ready? EllipTX comes standard on new Discovery MR750 scanners—or as a no-charge retrofit to your existing Discovery MR750 system. So don't wait to move to tomorrow ... today. ■



4-Port Drive + EllipTX[2] adds phase delay & reduces RF power.

Phantom Simulation improves uniformity by two times.

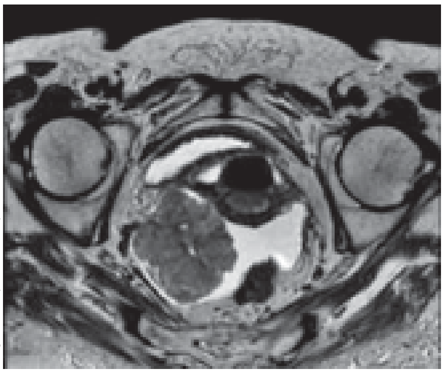


Image courtesy of University of Hull.

Turning Vision Into Reality With Dedicated Global Collaborators

The 2010 GE Healthcare thought leadership class unveils perspectives in innovation

For the fourth year, GE Healthcare embraces the achievements of magnetic resonance (MR) innovators—and its partnerships with these global leaders.

"Turning vision into reality takes perspective to see what's possible in the world. When that perspective is matched with innovative technology and a dedicated collaborator, a scientific vision can be realized," explains Jim Davis, Vice President and General Manager, GE Healthcare. "We salute those who apply their uncompromising vision to advancing the field of MR. Just as their work revolutionizes science today, so will it touch lives tomorrow. We are honored to be a part of it."

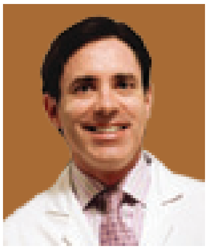
This year's class includes enthusiastic, inspiring individuals who demonstrate perseverance and commitment to furthering the boundaries of MR. The topics include: child-friendly MRI; imaging around metal and reducing metal artifacts; developing new applications; correcting instabilities; inventing and customizing; tracking treatment response; imaging in psychiatry; MR in cardiology; studying neuro infection; ultra short sequencing; pioneering MRE; weighting the signal; ideal algorithms; and pioneering 3.0T in MSK.

"Realizing scientific vision most effectively requires a global perspective. The challenges of healthcare are found everywhere, but so is the talent that the world needs to address them," says Davis. "This year, as in past years, we have identified those who are changing the face of MR. More than ever, we are committed to finding the best collaborators—wherever they may be."

These topics are for research use only and not commercially available. ■

Shreyas Vasanawala, MD, PhD—Assistant Professor of Radiology, Lucile Packard Children's Hospital, Stanford University (Palo Alto, CA). Dr. Vasanawala's work is focused on making MRI technology more child-friendly and reducing the need for anesthesia. His team is developing and integrating specialized pediatric body coils, improved parallel imaging combined with compressed sensing, and motion correction. Combining these advanced technologies is critical to achieve the acceleration and SNR needed in pediatric imaging.

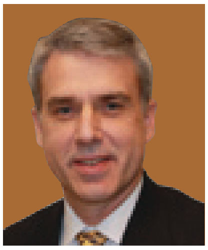
Brian Hargreaves—Assistant Professor of Radiology, Stanford University (Palo Alto, CA). Dr. Hargreaves' research team develops MRI techniques for applications in body, vascular and musculoskeletal imaging, including cancer detection. His current work includes a new MRI technique to correct the severe distortion artifacts caused by metal. He is hoping to achieve acceptable scan times with a reduction of artifacts, allowing standard spin echo contrast mechanisms with 3D imaging.

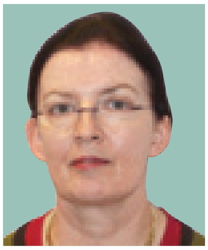


Stephen B. Solomon, MD—Chief of Interventional Radiology, Memorial Sloan-Kettering Cancer Center (New York, NY). Dr. Solomon is actively working to help develop both hardware and software systems that expand the clinical applicability of interventional MRI. His specific focus is tumor ablation with high-intensity focused ultrasound, laser ablation, and cryoablation. In collaboration with GE Healthcare, he has worked to develop larger-bore MR, in-room monitors, tableside controls, interventional coils, and in-room lighting, and improve software around real-time MR imaging, needle tracking, and thermal mapping.

Wally Block, PhD—Associate Professor, University of Wisconsin–Madison (Madison, WI). Dr. Block has been developing technology to support robust imaging with 3D radial trajectories for high-resolution encoding with very short repetition times to support fat/water separation with FIESTA sequences. His team developed a set of combined methods for correcting system instabilities on a per-patient basis that allow for consistent, high-resolution, non-Cartesian imaging on more than 3,000 patients. His temporal filtering methods exploit the variable sampling density in 3D radial trajectories for time-resolved angiography, perfusion imaging, and interventional imaging. These methods have shown promise for cartilage evaluation, whole joint evaluation, breast lesion characterization, diffusion-weighted imaging, and non-contrast-enhanced angiography.

Peter Roemer, PhD—CTO, Specialty MR, GE Healthcare (Wilmington, MA). As the principal inventor on MR phased arrays and known for the introduction of shielded gradient coils on commercial MRI systems, Dr. Roemer was a key architect for early development of the first 3.0T research systems for functional imaging with EPI and GE's SP5 Interventional system. Recently, Dr. Roemer's interests are directed to the development of specialized MRI systems, including MSK extremity systems at 1.0T and 1.5T. His long-term vision is to create greater access to the technology for patients worldwide by developing a family of high-quality, specialized MRI systems that serve the majority of applications, are lower cost, and easier to site, install, and operate than whole body systems.



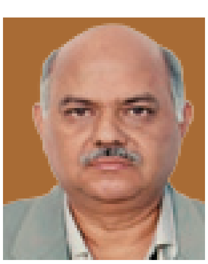


Lindsay W. Turnbull, MD, FRCR—Professor, Hull Royal Infirmary (Hull, UK). Dr. Turnbull's team develops reliable surrogate biomarkers of tumor response to neoadjuvant chemotherapy (NAC), helping to minimize ineffectual and costly treatment. Because vascular and metabolic parameters provide a more sensitive indicator of early tumor response than changes in volume, her team is investigating the role of a number of such parameters. These include textural analysis, measurement of T2 relaxation time, water-to-fat signal ratios using spectroscopy and IDEAL chemical shift imaging, and pharmacokinetic modeling of dynamic data. Dr. Turnbull's current study seeks to improve the diagnostic accuracy of a number of areas of interest, namely the surveillance of women at high risk of breast cancer, accurate diagnosis and staging of gynaecological and prostatic malignancies, and whole-body imaging to rapidly and repeatedly assess distant disease.

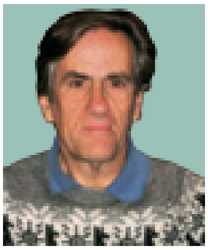
Kevin Koch, PhD—Scientist, GE Healthcare (Milwaukee, WI). Dr. Koch has spent several years developing multi-spectral 3D imaging techniques that can produce low-artifact MR images near metal implants. The unique soft-tissue contrast and resolution of MRI can diagnose a variety of complications around implanted orthopedic devices. Despite this potential, metal-induced susceptibility artifacts often significantly degrade the quality of conventional MR images. Multi-spectral 3D imaging divides the MRI acquisition into many spectral segments, each of which possesses minimal artifacts. These individual spectral segments can be combined to form a single composite image that, like its constituent components, has significantly reduced metal artifacts.

Steve Williams, PhD—Professor of Imaging Sciences, Institute of Psychiatry, Centre for Neuroimaging Sciences (King's College, London). Dr. Williams is a champion of neuroimaging in CNS disorders. His work focuses on the translation of imaging techniques from bench to bedside. Increasingly, his emphasis is on developing the clinical utility of imaging in psychiatry.

Massimo Lombardi, MD, FESC—Director, MR Cardiovascular Unit, C.N.R./G. Monasterio Foundation (Tuscany, Italy). Dr. Lombardi, who works within Italy's largest institution for the treatment of cardiac disease, is known for his ground-breaking work and leadership in the use of MR in cardiology. Scientifically, his team divides its time among clinical research, the assessment of myocardial iron overload in thalassemic patients, and the investigation and imaging of cardiac metabolism. His unit is unique for integrating clinicians and scientists—including cardiologists, physicists, engineers, chemists, technologists, and biologists—resulting in diverse dialectic analyses of results.



Rakesh Gupta, MD—Professor, Sanjay Gandhi Post Graduate Institute of Medical Services (Lucknow, India). Dr. Gupta has conducted pioneering research on neuroinfectious diseases since the late 1980s. He was among the earliest adopters of 1H MRS, and has extensively researched the use of magnetization transfer contrast in the study of infection. Recently, Dr. Gupta has focused on the use of diffusion tensor imaging in both brain developmental and neuro-infectious diseases. His work has the promise of finding new ways to fight diseases that affect millions worldwide.



Yuval Zur, PhD—MRI Physicist, GE Healthcare (Haifa, Israel). Dr. Zur is the inventor of RF spoiling in short TR gradient echo imaging and has contributed to the understanding of SSFP techniques. Currently, he is developing ultra-short sequences for Focused Ultrasound applications to allow continuous temperature measurement of multi-slice data during free breathing, as well as real-time correction of the focused ultrasound beam. In collaboration with Applied Science Lab scientists, Dr. Zur recently helped develop a robust artifact correction method for echo planar imaging.

Lee Jeong Min, MD—Associate Professor, Seoul National University Hospital (Seoul, South Korea). Dr. Lee's main interest is hepatobiliary-pancreas imaging and image-guided intervention for liver malignancies. He recently played a pioneering role in showing the promise of MR Elastography for differentiating liver tumors.

Hihohiko Kimura, MD, PhD—Professor, Department of Radiology, Fukui University (Fukui, Japan). Dr. Kimura is a pioneer in the technique of arterial spin labeling. ASL is a means of non-invasive MR perfusion assessment that can provide a quantitative value of cerebral blood flow. In the past, this method has not been routinely used because of a low signal-to-noise ratio. But using 3.0T MR, Dr. Kimura implemented a new ASL sequence based on 3D spiral FSE acquisition using pseudo continuous arterial labeling and background suppression technique. This makes the technique compatible with body coil excitation and covers whole brain perfusion with much better SNR than before.

Huanzhou Yu, PhD—Scientist, GE Healthcare (Menlo Park, CA). Dr. Yu is working on projects that include an effort to improve the efficiency and reduce the scan time of current by using a more efficient "bipolar" acquisition and fat likelihood mapping—a new way to identify water and fat by exploiting their spectral differences.

Ron Shnier, MD—Director, Diagnostic MRI Services, Southern Radiology (Sydney, Australia). Dr. Shnier is known as a pioneer in bringing high-field MR to Australia and one of the first to use 3.0T there as a clinical tool for MSK. His clinical research has covered the use of diffusion sequence to show early cartilage damage, as well as using UTE imaging to assess cortical bone and entheses. Dr. Shnier's group validated the use of MRI in assessing damage in rheumatoid arthritis and was part of the team establishing a scoring system of inflammation and damage. Currently, his areas of focus include high-resolution 3D imaging for joints, UTE applications, use of MRI-guided procedures in the treatment of soft tissue and bone tumors, and high-resolution endorectal coil imaging of the prostate.

High-Field

Strength Extremity MR Scanning

Frees over-scheduled whole-body MR scanners

It's 9 a.m. and your radiology department's MR schedule is packed with back to back scans—breast, brain, cardiovascular, and spine mixed in with ankles, wrists and knees. Your whole-body scanners are at full capacity.

Wouldn't it be prudent to keep your whole-body scanners available for neuro, body, cardiac and breast scanning, and provide your musculoskeletal patients with a more comfortable experience—all without compromising image quality? Extremity-specific MR imaging, at 1.5T strength, offers the best of both worlds—radiologists get the image quality they need to make an informed, confident diagnosis, and patients enjoy the comfort they deserve.

GE Healthcare is on the brink of changing the face of extremity-specific MR imaging with the world's first high-field strength, extremity-specific MR system*.

Cost, quality and access

Whole-body MR scanners can be effective at imaging extremities—approximately a quarter of all MR scans are ordered for extremities, ranging from wrists and hands to knees and ankles—but those systems are also in high demand for brain, cardiovascular, spine, and abdominal imaging.

A whole-body scan, while often effective, can seem like a significant procedure for such a targeted area. Further, the whole-body MR experience can be stressful and uncomfortable for some patients, particularly when claustrophobic or asked to hold an extremity in a static position for a long time.

While smaller, extremity-specific MR systems have been on the market for years, they have not been widely adopted because of their low field strength and resultant poor image quality.

"In healthcare, products are measured on cost, quality and access. I've been in the industry for more than 20 years, and rarely do we see a product that qualifies for all three. I can say with confidence that GE Healthcare is on the brink of changing that as it relates to extremity-only MR imaging," comments Paritosh Dhawale, General Manager of the Extremity Scanner Business at GE Healthcare. "It's important to increase productivity, but at what cost? Our extremity scanner offers a practical, affordable, smart way to add capacity with less risk and no compromise."

Increasing capacity affordably

In these tough economic times, affordability and value are critical. For hospital administrators, this means freeing over-scheduled whole-body MR systems to do more of what they do best, while also offering a differentiator to their referral base. And for clinicians it means reliable, clear images to help them make accurate diagnoses.

For the department and facility as a whole, it means increased productivity, which translates to cost savings.

"Our extremity-specific 1.5T MR system is one-third the cost of a premium whole-body 1.5T scanner, but radiologists won't have to compromise on image quality—and they'll gain productivity," remarks Dhawale. "With a smaller footprint relative to whole-body systems, it saves space and also consumes less energy."

Additionally, the MR industry is seeing more requests for scanners to meet a specific need; for example, patients with claustrophobia. Furthermore, many radiologists are choosing to focus their attention and excel in an anatomy-specific clinical area—be it neuro, breast or abdominal. An extremity MR system has the potential to attract new patients and referrals.

Exquisite images diagnosing the pros

In 2009, GE Healthcare expanded into the extremity-specific arena by purchasing certain assets of ONI Medical Systems. The two new systems that became part of the GE Healthcare portfolio were the MSK Extreme 1.0T and the MSK Extreme 1.5T. The Optima† MR430s*, which is currently pending 510(k) clearance by the FDA, is based on technology and comfort currently available on the ONI MSK Extreme 1.5T.

> "It's important to increase productivity, but at what cost? Our extremity scanner offers a practical, affordable, smart way to add capacity with less risk and no compromise."
>
> *Paritosh Dhawale, General Manager of the Extremity Scanner Business, GE Healthcare*

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

"It's important to us to develop the right-sized scanners for the right anatomy. The new scanner is a fundamental and deliberate move that supports the needs of radiologists and patients."

Jim Davis, Vice President and General Manager for Global MR at GE Healthcare

The image quality of the Extreme 1.5T was so amazing that professional athletes, such as Philadelphia Eagles football players and professional dancers, have turned to it for an MR scan.

Abigail Mentzer, a dancer with the Pennsylvania Ballet company, had her problematic ankle scanned on the ONI MSK Extreme 1.5T installed at Thomas Jefferson University in Philadelphia. Because of the exquisite image quality, Dr. William Morrison—director of the division of musculoskeletal radiology at Thomas Jefferson University in Philadelphia—was able to diagnose a large fluid-filled cyst called a ganglion, which pinched when she counter flexed. Mentzer underwent a procedure to fix it in a timely manner.

Given the system is designed to be specifically dedicated to MSK imaging, some radiologists have said they believe the ONI MSK Extreme 1.5T offers advanced clinical capabilities that rival whole-body MR systems. Many academic sites require radiologists to work closely with the country's top orthopedic surgeons—so getting the best MSK image quality is critical.

A surprisingly calm experience

The ONI MSK Extreme 1.5T offers a vastly more comfortable MR scanning setting for patients. While the magnet is powerful, the experience is surprising—smaller, friendlier, more tailored, more personal, and quicker. The system's design and adjustable chair make the clinical exam as comfortable as possible, without requiring awkward body positions. A wrist, for example, can only take 15 minutes from start to finish.

"The scan was a piece of cake," says Mentzer. "I popped into the clinic, sat in the comfy chair, stuck my foot in, and read a book. Unlike the whole-body scanners, it wasn't scary at all. It was easy, simple, fast."

With a scanning chair that is comfortable and adjustable, the relaxed sitting position often helps calm the patient during the scan. In fact, radiologists have noticed that even anxious patients are more comfortable in this nontraditional environment.

Changing the face of MR

Many radiologists agree that high-field, anatomy-specific imaging is the wave of the future for radiology departments. GE Healthcare's extremity scanner illustrates the company's dedication to this kind of innovation—developing thoughtful, surprising products to bring better health to more people.

"It's important to us to develop the right-sized scanners for the right anatomy. The new scanner is a fundamental and deliberate move that supports the needs of radiologists and patients," comments Jim Davis, Vice President and General Manager for Global MR at GE Healthcare. "We're hard at work to develop and design the next generation of scanners appropriate to specific parts of the anatomy." ■

Extremity Imaging Takes a Big Step Forward with a Small Footprint

Coming soon to medical conferences are images from an unexpected source—the ONI MSK Extreme 1.5T. Patient comfort and ease of operation are the winning qualities of this MRI system, dedicated to extremity imaging.

Yet this compact powerhouse is full of surprises, helping surgeons pioneer new techniques for the treatment of deep cartilage defects in the knee assess, and even adapting their techniques—thanks to the advanced capabilities of extremity imaging.

Autologous chondrocyte implantation (ACI) is being used increasingly for the treatment of cartilage defects in the knee. To gather the information required for this complex procedure, the patient receives between four and five MRI exams—a demanding requirement that places patients in awkward positions while requiring technical staff to perform a series of gymnastics with a whole-body scanner setting up sequences.

Convinced after a few months of evaluations that the dedicated ONI MSK system at the Clinica CEMTRO in Madrid, Spain had earned its wings, matching the quality of the Signa† HDxt 1.5T system for image quality in routine exams, the head of radiology Mario Padron, MD, decided to give the new unit a spin around a series of ACI exams.

"Our hospital is a pioneer in cartilage repair with a surgeon who is quite well known for the creative techniques he has developed," he says.

Dr. Padron said his department has been performing pre-surgical assessments and post-surgical follow up for 12 years, most recently using the Signa HDxt 1.5T whole-body system.

"When we began to study the post-processed T2 mapping, we were really impressed by how well it worked."

Dr. Mario Padron

"For the purpose of this examination, we need the usual sequences to characterize the morphology of the cartilage and pulse sequences like IDEAL," he explains. "We thought it would be interesting to do this follow up with the ONI scanner because it is easier on the patients, and we knew that the exam times would be at least the same, possibly a little faster, than with the whole-body system."

Dr. Padron continues, "Then we thought that if we could do the T2 mapping as well, we would have everything we needed." Using a spin echo sequence, he acquired multiple TE acquisitions on the ONI and then processed the data on GE's Advantage Workstation to create T2 map* overlays, including regressions and color mapping.

"When we began to study the post-processed T2 mapping, we were really impressed by how well it worked. We saw a good correlation between the morphological aspect of the articular cartilage and the mapping of the water content in the new hyaline cartilage that was forming [from the ACI procedure].

"These are critical clinical assessments," he says. "There are complications with this type of surgery, including rejection of the hyaline cartilage. We found we could confidently follow these morphological aspects with the MSK. The water content with the T2 mapping allowed us to assess the quality of the new cartilage forming after the implantation of the chondrocytes and quantify the growth of fibrocartilage."

Having won over the orthopedic surgeons with the clinical quality of the ONI MSK reports, Dr. Padron is ready to push the boundaries of Extreme 1.5T imaging.

Dr. Padron is looking into the use of other MR imaging techniques that will allow him to assess the biological behavior and functional assessment of the repair. ´We want to know how well the cartilage is forming after the surgery," he adds, "as this is absolutely fundamental to validating the effectiveness of this surgical technique."

To this point, Dr. Padron has conducted ACI follow up for 12 patients with morphological exam sequences on the ONI MSK Extreme 1.5T and expects to begin the functional studies before the end of the year.

T2 mapping images

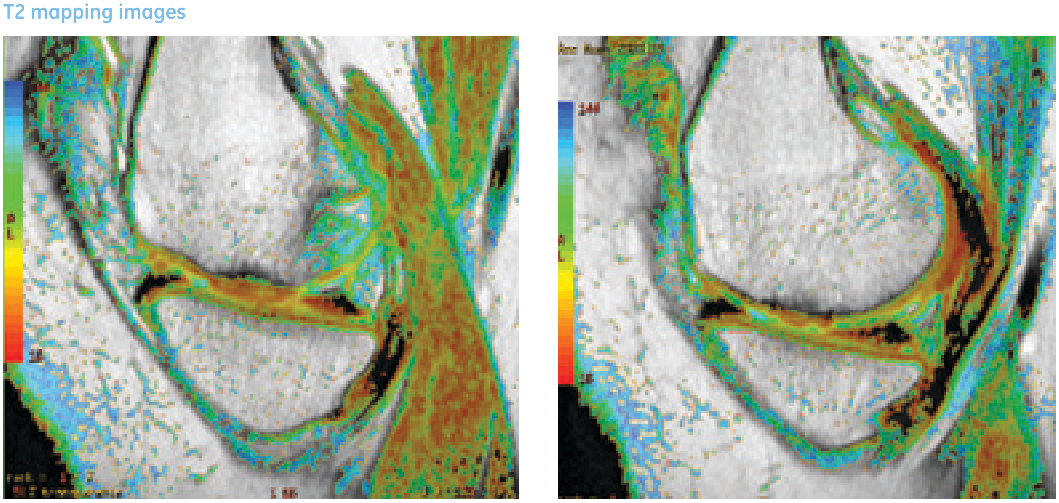
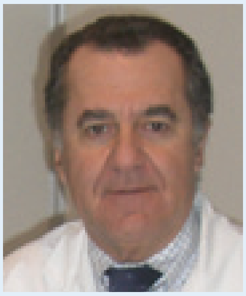


Figure 1: Multiple TE acquisitions acquired on ONI were processed on GE's Advantage Workstation to create T2 mapping prior to ACI for evaluating degradation of cartilage. T2 mapping is useful to reveal areas of increased or decreased water content, which correlates with cartilage damage.

*T2 mapping was done experimentally by Dr. Padron on GE's Advantage Workstation using Functool.



Dr. Mario Padron

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

About the facility

Clinical CEMTRO (Madrid, Spain) specializes in Orthopedics, Traumatology, Sports Medicine, Rehabilitation, Physiotherapy, Podiatry and Othotics under the guidance of Orthopedic Traumatology scientist Professor Pedro Guillén García. The 100-unit Day Hospital houses six operating rooms and provides spacious single rooms for short-stay and ambulatory patients. Implementation of an electronic medical record enables clinicians to know the status of all patients in real time.

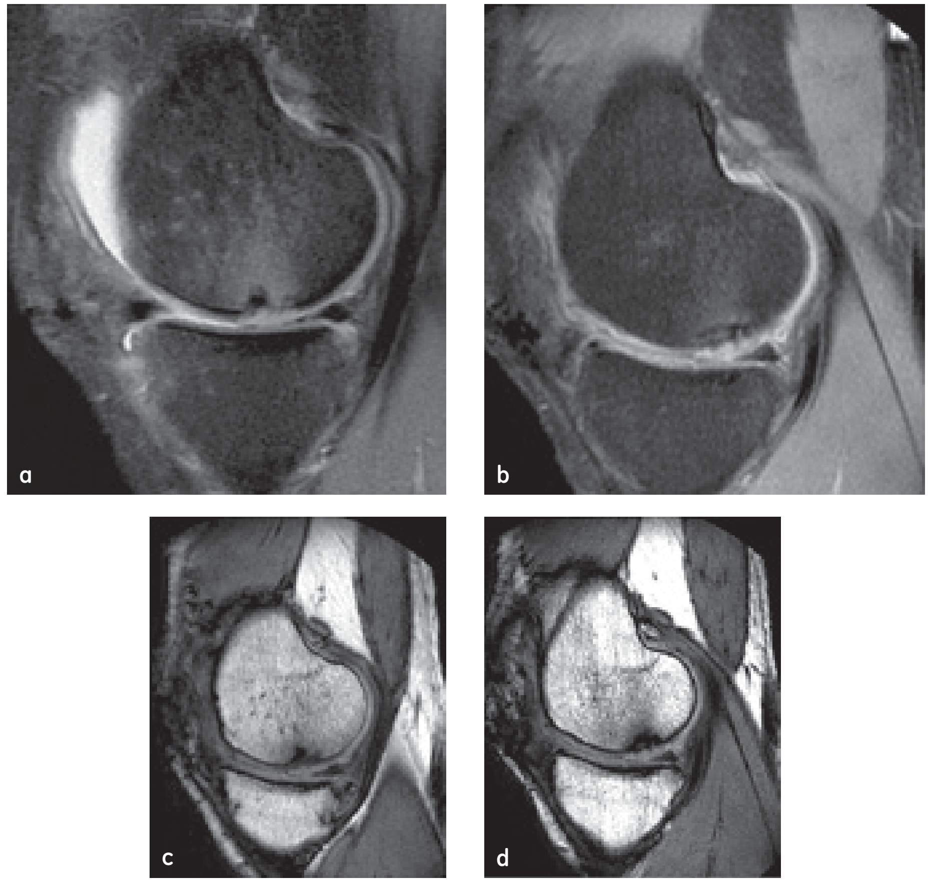


Figure 2: PD Sagittal images taken six months (a) and 18 months (b, c, d) after ACI to evaluate cartilage repair process. 2c and 2d are out-of-phase.

Asked what the whole body scanner continues to offer for extremity imaging that can not be done on the dedicated MSK system, Dr. Padron replied, "Nothing."

"We know we can conduct exams equally well on both," he offers. "We did not know if it was going to be worthwhile doing spin echo sequences at varying TEs and then post-processing the ONI image data to create T2 overlays, but now our confidence in the technique is very high."

Operating times on the two systems are nearly equal at 20 minutes, he reports, adding, "[With the ONI] the throughput of patients is faster, the protocols and set up are easier, and it is much more comfortable for the patient. At times setting up the whole-body system for this type of exam could be complicated, but for us ACI follow up with the features on the ONI MSK has made it a routine exam." ■

Working in Tandem

MRI center seeks to increase volume and breadth of studies by adding extremity and wide bore scanners

As a dedicated MR imaging center, Spruce MRI Associates is focused on providing exceptional service to patients and physicians. That includes offering an array of systems designed to meet the varying needs of different specialists.

Take the GE ONI Extremity 1.5T MR or the Optima† MR450w wide bore systems, for example. Already armed with a recently upgraded, workhorse Signa† HDxt 1.5T, Spruce saw an opportunity to expand their referral base by adding an extremity scanner for dedicated orthopedic and small body MSK imaging and a wide bore for larger-sized and claustrophobic patients.

"We now have a diverse group of scanners, so there is really no reason why a patient couldn't get an MR scan here," says Christine C. Hawkinson, MBA, administrator at Spruce.

"Any extremity imaging we schedule right on the ONI," adds Richard X. Wiler, RTR (MR) lead technologist. Spruce plans to market this capability to orthopedic and hand centers to increase study volume. "We actually bought this scanner for these types of practices," he says, "and we'll tell them that."

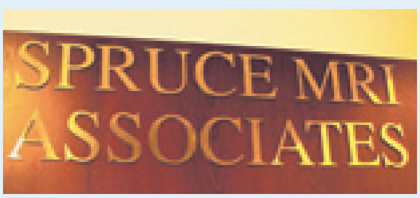
Clinicians, says Carol A. Dolinskas, MD, Medical Director, will also see the value of high quality extremity imaging from the ONI. "Comparable to other high field MR scanners, I think the image quality is actually better for the hand and toes." Plus, she adds, unlike traditional open bore scanners, the ONI offers a variety of MR sequences such as fat suppression and post-contrast studies.

These capabilities increase the clinical utility of both the extremity and the HDxt system by off-loading MSK work from the whole body scanner. With the MSK studies scheduled on the ONI, the whole body scanners can be utilized more for abdomen, hips and shoulders, neuro, vascular, and breast. The new wide bore will be used for larger-sized and claustrophobic patients and to introduce new imaging capabilities to their referral base, such as Diffusion Tensor Imaging. This results in streamlined scheduling and new opportunities to fit emergency or same-day exam requests onto the whole body scanner.

Figure 1. Images of the elbow are: (a) T2 FS axial; (b) T1 coronal; (c) T2 FS sagittal. T2 Fat Sat and T1 images demonstrate bright fluid surrounding the area of the biceps tendon, indicative of edema within the tissue due to the partial tear of the tendon.

Dr. Carol A. Dolinskas

Carol A. Dolinskas, MD, is the Medical Director of Spruce MRI Associates, Chief, Section of Magnetic Resonance Imaging and Chief of Neuroradiology at Pennsylvania Hospital, and a Clinical Associate Professor of Radiology at The University of Pennsylvania School of Medicine. She earned her medical degree from Thomas Jefferson Medical College and completed her internship and residency at Pennsylvania Hospital. Her areas of interest are bloodless medicine, magnetic resonance imaging and neuroradiology.



About the facility

Spruce MRI Associates was started in 1987 for the sole purpose of providing MR imaging to the center city Philadelphia population. The center is located on the campus of Pennsylvania Hospital — the first hospital in the US. Through the years, Spruce has grown to not only service center city, but the entire Tri-State area. Referring physicians and patients recognize Spruce MRI Associates as a leading MRI facility with superior scan quality, patient service and state-of-the art equipment that includes a Signa HDxT 1.5T, GE Optima 450w wide bore 1.5T, and GE ONI Extreme 1.5T scanner. Visit www.sprucemri.com for more information.

Plus, with reductions in MR imaging reimbursement, the ONI Extremity 1.5T MR scanner makes financial sense. The extremity scanner can generate the same high quality images of small body parts as a whole body scanner, yet it costs approximately one-third less. That leaves more revenue for the bottom line.

In fact, the center's vision for all three systems is to work in tandem to efficiently deliver a mix of studies each day. Wiler expects that in a typical 13-hour day, the center's three MR systems could easily scan up to 60 patients.

And that, says Hawkinson, will lead to even better service to patients and referrers. "We pride ourselves in getting patients in and out quicker—they don't have to wait weeks for an appointment. Now, with the high field, extremity and wide bore, we'll have even more room to maneuver patients and optimize each scanner."

Better, more timely patient service coupled with high quality imaging can also increase the size of the center's referral base. For the first time, Spruce will be marketing their services outside of their main, traditional referral core at Pennsylvania Hospital.

"Our message will be that Spruce is all encompassing imaging center where patients can go for all their MRI needs," adds Hawkinson. "We also take pride in being an all GE equipment site, and will reinforce their reputation for high quality imaging. ■

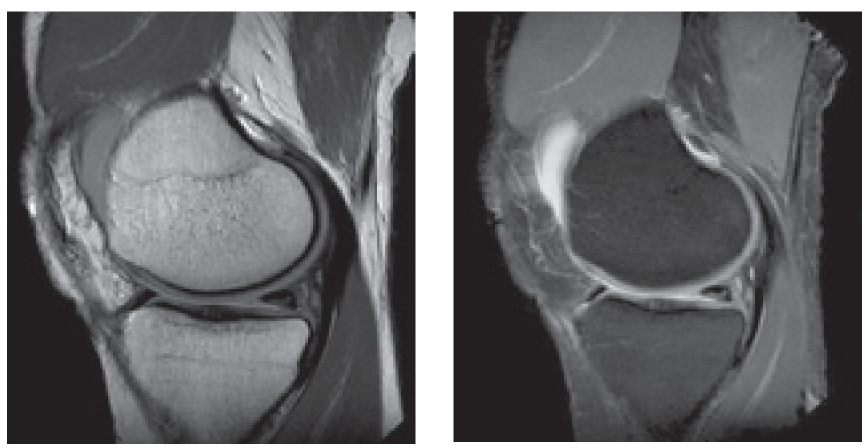


Figure 2. PD sagittal (left) and PD FS SmartFat sagittal (right) demonstrate a knee meniscal injury.

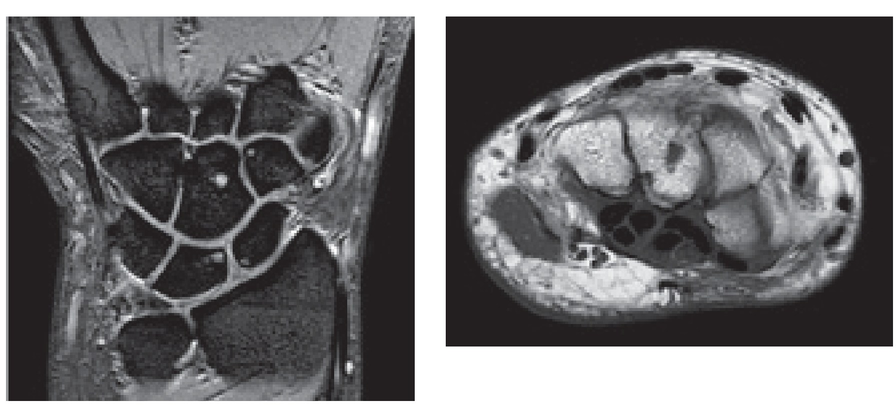


Figure 3. The GE ONI Extreme 1.5T MR offers Spruce MRI Associates a variety of sequences such as FSE, GRE, and FSEfw (SmartFat-fat water separation technique). These wrist images are a T2* GRE coronal (left) and a T1 axial (right).

Keep It Clean!

It's not just about looks, maintaining a cleaning regimen is important for promoting safety, too.

Five Steps To Take Today

The Joint Commission (formerly JCAHO) has said it is now focusing on the MRI setting, especially concerning IC protocols. Here are five elements a surveyor is likely to look for:

1. A detailed plan. The IC plan should be specific to the MRI suite, including safety elements and specific procedures for cleaning the bore and the pads.
2. Goals and strategies. Again, these should be specific to the MRI Suite.
3. A person designated for cleaning. One person should be dedicated to cleaning the MRI equipment—probably an MRI technician who understands the associated hazards. You could consider assigning tasks such as cleaning floors to environmental services.
4. Documented cleaning. Once you have established your cleaning schedule, develop a documented system.
5. Check and replace pads. Set up a schedule for pad inspections and a procedure for ordering new ones if damaged.

We do our best to keep our MRI suites in tip-top shape, but are we keeping them—and ourselves—as clean as we should? The importance of properly cleaning the bore, pads, coils, room, and even our hands to cut down on hospital-acquired infections has become a hot topic for administrators and the MR community.

In July 2008, Peter Rothschild, MD, president and founder of Patient Care Systems, Inc. in Newark, CA released a white paper that detailed infection control (IC) concerns, including a lack of cleaning procedures and a detailed IC plan specific to MRI.

In May of 2009, he released a survey to support his assertions. He asked 100 facilities (53 hospitals, 47 independent outpatient imaging centers) if they had an infection control plan that included the MRI scanner, and if employees adhered to it. The survey found an absence of written policies and any infection control procedures were a result of preferences or training of the MRI technologist.

Balancing safety and cleanliness

For years, many MRI suites in hospitals and outpatient facilities have operated without proper IC procedures, primarily because the dangers of the MRI's magnetic field bar almost all employees from entering the room. As a result, the area has flown under the IC radar.

Employee safety is one of the main reasons that the MRI suite lags behind in IC and environmental cleaning. Because the area contains a powerful magnet, it creates a hazard for those unaware of how it operates. Since dangers exist, including projectiles, the suite is usually restricted to MRI technologists and operators.

Establishing proper IC procedures

Safety hazards can make it easy to ignore IC in MRI suites, but the risks make it essential to create a written, detailed plan that includes specific responsibilities and procedures. Following are 11 steps from the OSHA Healthcare Advisor on IC procedures for MRI facilities in hospitals and outpatient centers.

1. Develop an appropriate written infectious control policy to include MRI cleaning procedures as well as a cleaning schedule and have it posted throughout the MRI facility.
2. Implement a mandatory hand washing/hand sanitizing procedure between each patient not only for MRI technologists, but for all others who come into contact with patients.
3. Clean the MRI system, tables, inside the MRI bore, and any other items that come into contact with the patient. Infection control experts recommend this be done between each patient.
4. Clean all comfort pads and positioning sponges with an approved disinfectant. Infection control experts recommend cleaning after each patient.
5. Periodically inspect the pads and positioning pads with a magnifying glass, particularly at the seams, to identify fraying or tearing. If present, the pads should be replaced.
6. Regularly check all padding material with an ultraviolet (black) light and make sure that any biological material detected on the pads can be removed.
7. Replace damaged or contaminated pads with new pads incorporating permanent antimicrobial agents.
8. Use pillows with a waterproof covering that is designed to be surface wiped. Replace pillows when their barrier is compromised.
9. Promptly remove any body fluids and then surface disinfect all contaminated areas.
10. If a patient has an open wound or any history of MRSA or other infection:

    a. Gloves and gowns should be worn by all staff coming in contact with the patient. These barriers must be removed before touching other areas not coming in contact with the patient, i.e. door knobs, the scanner console, computer terminals, etc.

    b. The table and all the pads should be completely cleaned with disinfectant before the next patient is scanned, if it is not already being performed between each patient. For patients with any known infectious process, add 10 to 15 minutes onto the scheduled scan time to assure there is enough time to thoroughly clean the room and all the pads.
11. All furniture should be periodically cleaned. Ideal surfaces are those that are waterproof and easily wiped. Infection control experts recommend this be done between each patient.

For more information on MRI compliance and IC, visit OSHA Healthcare Advisor at www.oshahealthcareadvisor.com. ■

MRE Cost Effectiveness: Preliminary Threshold Assessment

By David W. Lee, PhD, Vinod Palathinkara, PhD, GE Healthcare and Mitch DeKoven, IMS Health

Introduction

Liver biopsy is the most specific test to assess the nature and severity of liver diseases.[1] While often considered the reference standard, liver biopsy can yield false-negative results in nearly one-third of cases[2,3] and is characterized by a morbidity rate of 3% and a mortality rate of 0.03%.[2] As such, noninvasive methods are being developed as a means for detecting liver fibrosis. Magnetic Resonance Elastography (MRE) is a promising noninvasive technique for evaluating tissue stiffness and liver tissue characterization.[4]

This study estimated the accuracy needed for MRE to be cost-neutral, as compared to liver biopsy, from a US Medicare perspective.

Methods

We conducted a targeted literature review to identify the full range of services that accompany both a liver biopsy and MRE. A leading hepatologist and pathologist were consulted in order to identify the appropriate procedure codes associated with both modalities. We assumed that MRE would be reimbursed using CPT-4 code 74181 (Magnetic resonance [eg, proton] imaging, abdomen; without contrast material[s]).[5]

Payment amounts were assigned to the identified procedure codes using the Medicare 2010 Physician Fee Schedule, the Medicare 2010 Hospital Outpatient Prospective Payment System,[6] and the Medicare 2010 Clinical Laboratory Fee Schedule. Payment rates were subsequently stratified into both payer and patient responsibility, based upon patient out-of-pocket responsibility.

The payment amounts were incorporated into a decision-analytic model that compared the costs for patients with suspected liver fibrosis via two scenarios: 1) biopsy or 2) MRE followed by biopsy when the MRE test was positive. We assumed MRE negative predictive values (NPV) of 0.8, 0.9 and 0.95 and patients with a false-negative MRE would ultimately receive a biopsy.

Results

The cost of an ultrasound-guided liver biopsy in the hospital setting, from the US Medicare payer perspective, is $1,443.68 (ultrasound: $120.96; surgical: $730.97; pathology: $271.10; laboratory: $25.54; evaluation and management: $295.11 (Table 1).

Table 1: Liver biopsy costs*

Liver Biopsy Costs	Professional Fee	Facility Fee	Total
Ultrasound	$23.67	$97.29	**$120.96**
Surgical (i.e., biopsy)	$79.38	$651.59	**$730.97**
Pathology	$128.18	$142.92	**$271.10**
Laboratory	$25.54		**$25.54**
Physician Evaluation and Management	$127.59	$167.52	**$295.11**
Total	**$384.36**	**$1059.32**	**$1443.68**

*Cost to Medicare program (80% of allowable charge) excluding cost sharing

Table 2: MRE Costs*

	Hospital Setting			Non-Hospital Setting
Cost Category	Professional Fee	Facility Fee	Total	Professional Fee Only
Imaging	$58.89	$349.53	**$408.42**	$360.27
Kidney Function tests	$20.34		**$20.34**	$20.34
Physician Evaluation and Management	$127.59	$167.52	**$295.11**	$152.42
Total	**$206.85**	**$517.05**	**$723.87**	**$533.03**

*Cost to Medicare program (80% of allowable charge) excluding cost sharing

The cost of an MRE (without contrast) in the hospital setting, from the US Medicare payer perspective is $723.87 while in the non-hospital setting it is $533.03. (Table 2)

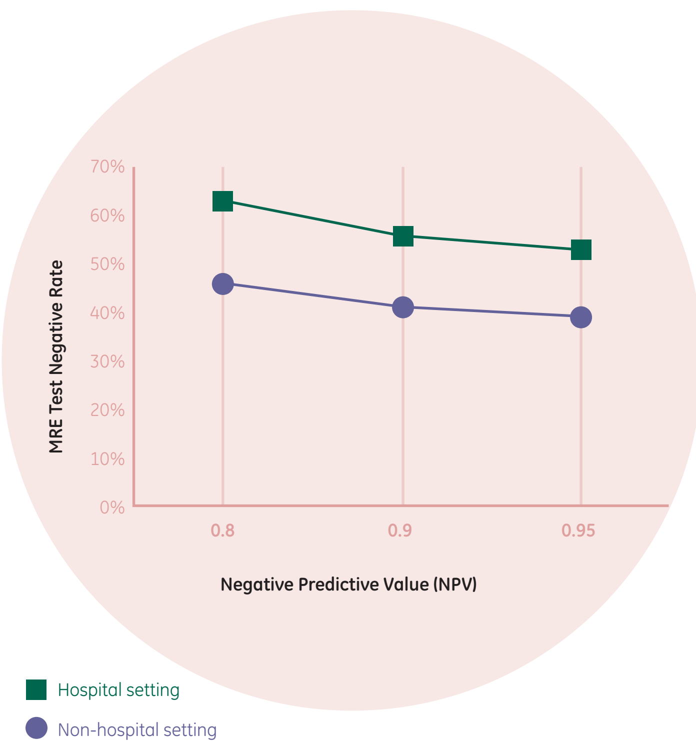


Figure 1: MRE vs. liver biopsy—cost neutral comparison; shows MRE test negative rates needed for MRE to be cost-neutral for selected MRE negative predictive values.

As shown in Figure 1, MRE potentially saves cost in the hospital setting if the test-negative rate is greater than 63%, 56%, and 53% for NPVs of 0.8, 0.9, and 0.95, respectively. In a non-hospital setting, MRE can reduce diagnostic costs when more than 46%, 41%, and 39% of patients have negative MRE results for the corresponding NPV values (0.8, 0.9, and 0.95).

Conclusions

The cost of liver biopsy is substantial as compared to MRE. As a triaging tool, MRE offers the potential to reduce costs of evaluating liver fibrosis. Cost saving potential increases with MRE's negative predictive value and negative test rate. ■

Editor's Note: This study was presented as a poster at the ISPOR 13th Annual European Congress held in Prague, Czech Republic, on November 6 to 9, 2010.

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MRE Cost Effectiveness: A Scenario Analysis

By Vinod S. Palathinkara, PhD, and David W. Lee, PhD, GE Healthcare

Given the novelty of MRE, peer-reviewed academic/medical literature on direct evaluation of potential cost-effectiveness of the technique in the diagnosis and management of liver fibrosis is not yet available. Nevertheless, indirect comparisons based on studies that compare stiffness measured using MRE and biopsy results can provide insights. A scenario analysis based on a peer reviewed literature comparing observations of a patient who had both biopsy and MRE is illustrated here.

MRE is currently not reimbursed as a stand-alone test with its own CPT code. Because the acquisition time for MRE is very short, the technique can be readily included in the protocol for an already indicated abdominal MRI exam with little impact of the typical examination time of 30 to 45 minutes. If the entire cost of such an exam is attributed to the MRE procedure, then a conservative estimate of the cost of MRE would be equivalent to the 2010 national Medicare average payment amount for abdominal MRI, i.e. $628 (CPT code 74183). At this stage, there is no way to predict the willingness of payers to cover an MRI examination conducted solely to perform MRE.

To better quantify the costs associated with MRE and liver biopsy, a decision-analytic model comparing diagnostic costs was constructed.[1] A targeted literature review was conducted and a leading hepatologist and pathologist were consulted to identify the appropriate procedure codes associated with liver biopsy. The study assumed that MRE would be reimbursed* using CPT-4 code 74181 (magnetic resonance [e.g., proton] imaging, abdomen; without contrast material[s]). All appropriate allowable charges were assigned to the identified procedure codes using the 2010 Medicare Physician Fee Schedule. All costs discussed here are US-based and are not globally applicable. Based on the model, the cost of a guided liver biopsy is $1,424 (ultrasound $164,

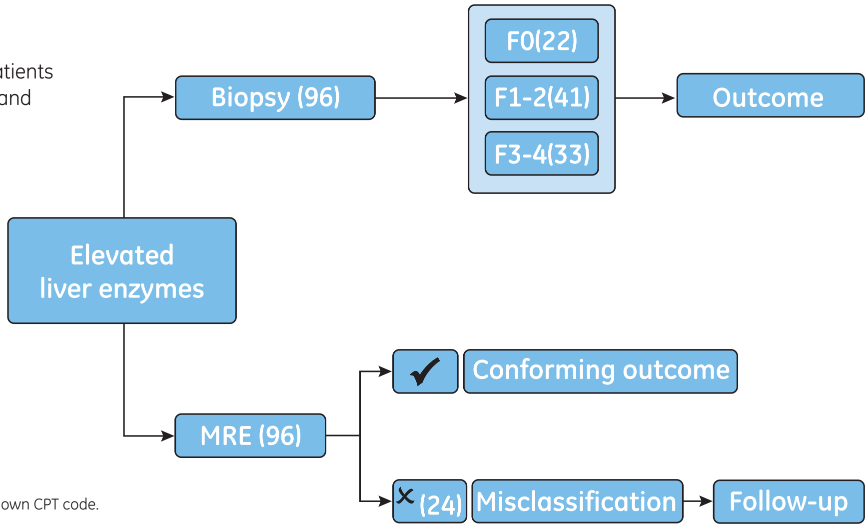

Figure 1. Flow diagram of patients who underwent liver biopsy and MRE (Huwart et al.).

*MRE is currently not reimbursed on its own CPT code.

Scenario 1

Biopsy is 100% accurate; all samples are suitable.

Costs for procedures:

Biopsy: 96 x $1,424 = $136,704

MRE: 96 x $946 + 24 x $1,424 = $123,100

Cost differential = $13,604, or 10% less than biopsy

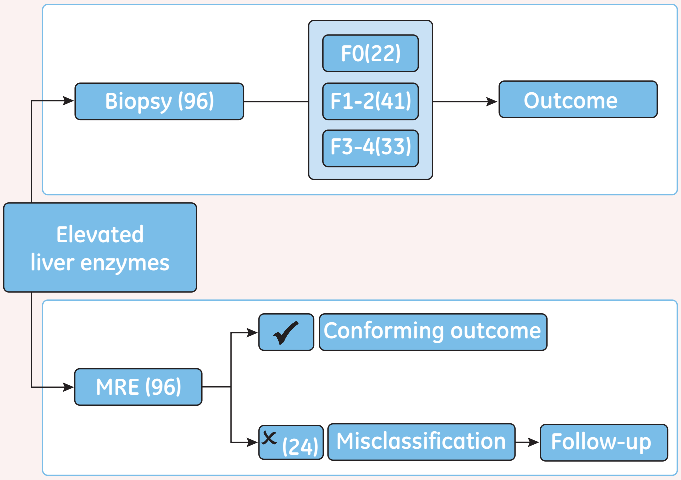

Figure 2. Hypothetical examples of direct costs of MRE and liver biopsy for scenario 1.

surgical $881, pathology $347, laboratory $32) and the cost of an MRE (without contrast) is $946 (hospital setting) or $666 (non-hospital setting).

Scenario Analysis

Huwart et al, performed a blind comparison of MRE and liver biopsy for non-invasive staging of liver fibrosis and reported histopathologic staging of liver fibrosis according to the METAVIR scoring system as the reference.[2] The study analyzed 96 patients who underwent both MRE and liver biopsy (Figure 1). It should be noted that the initial sample had 141 patients from whom liver biopsy specimens were collected, but only 127 liver biopsy specimens were suitable for fibrosis staging. This suggests that approximately 10% of the samples from a biopsy specimen may be unsuitable for staging.

We consider three scenarios as a hypothetical example to illustrate the costs of performing MRE for evaluation of liver disease. In scenario 1, we assume that liver biopsy is 100% accurate and the discrepancy in staging between MRE and liver biopsy is entirely due to the errors in MRE. From a cost perspective, this would mean that at some point in time, these patients would require follow-up for a definitive diagnosis. Since we are using biopsy as the reference standard, the cost for the follow-up is assumed to be the cost of a biopsy.

Scenario 2

Biopsy is 100% accurate, but 10% of samples are unsuitable.

Costs for procedures:

Biopsy: 96 x $1,424 + 9.6 x 1,424

= $136,704 + $13,670

= $150,374

MRE: $123,100 + 2.4 x $1,424 = $126,518

Cost differential = $23,856, or 16% less than biopsy

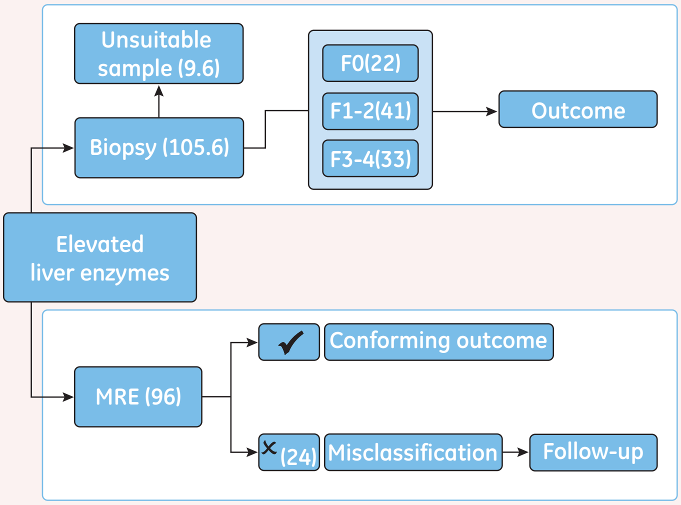

Figure 3. Hypothetical example of direct costs of MRE and liver biopsy for scenario 2.

Scenario 3

Biopsy is only 80% accurate, but MRE still has 25% misclassifications.

Costs for procedures:

Biopsy: $136,704 + 0.2 x 96 x $1,424

= $136,704 + $27,341

= $164,045

MRE: $123,100

Cost differential = $40,945, or 25% less than biopsy

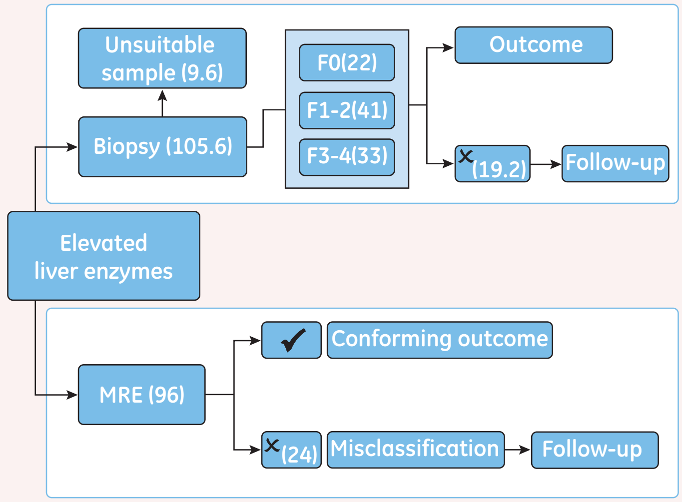

Figure 4. Hypothetical examples of direct costs of MRE and liver biopsy for scenario 3.

Huwart et al, report that in comparing results from MRE and biopsy, 24 of 96 (25%) were misclassified in their stage of fibrosis. Based on the reported sensitivity and specificity of MRE techniques, this misclassification is unusually high. Nevertheless, since biopsy is the reference standard, we assume that 25% of patients who underwent MRE would eventually require further evaluation and likely receive a biopsy. We do not consider how one would identify the misclassified patients and ignore the impact on the outcome or the additional treatment costs due to delay in misclassification. Our attempt here is to illustrate a methodology that can provide directional information on costs to explore potential for cost reduction rather than to establish or estimate actual cost differentials.

In scenario 1, we assume that biopsy is 100% accurate and all samples are sufficient for diagnosis. This is also considered a worst-case scenario for MRE. The study's authors highlight the fact that liver biopsy is not an optimal reference examination and that they do not know if the reported discordant results between MRE and histopathology were caused by problems of inadequate biopsy sampling*. The authors also report that the two pathologists who reviewed the biopsy specimen were initially in agreement for 81 of the 96 samples. Nevertheless, since biopsy is the reference standard, we assume it provides a clinically accepted basis for comparison.

As reported by Huwart et al, 14 of 141 samples were unsuitable for diagnosis. While many studies recommend a minimum sample length of 25mm, the study reports that 23% of the samples were less than 25mm in length. Thus the scenario that a few biopsy samples would be unsuitable is realistic.

In scenario 2, we assume that to obtain 96 good samples, one would need to do 10% more samples (105.6 biopsies). This assumption does not imply that these patients would undergo an immediate repeat biopsy. The cost of this may result in an increased cost of diagnosis per person.

In scenario 3, we take into account a biopsy leading to a misclassification. More than questioning the accuracy of the biopsy, this is reflective of the fact that biopsy is a sampling technique. Studies report biopsy mis-staging to be in the range of 10 to 33%. If we assume 20% of biopsy samples are mis-staged, then the discordances between MRE and biopsy may decrease. However, for simplicity, we still assume that the discordance between MRE and biopsy will not change.

Summary

We have illustrated a scenario-based analysis to compare potential cost differentials of MRE with other techniques that provide similar information. No recommendation on the likelihood of any scenario is being made. As the three scenarios show, the cost differentials for MRE (over biopsy) can range from 10% to 25% lower than direct biopsy costs. The key assumptions that determine the actual cost savings are accuracy of biopsy, sample suitability of biopsy, and accuracy of MRE. ■

*In 26 of the 96 samples, the biopsy specimen was less than 25mm.

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Blows to the Brain: Insight From Tragedy

Are you one of many people who think concussions aren't that big of a deal? Picture yourself playing a game such as soccer. You're heading the ball and another player slams into you, causing a blow to your head ... at first it seems minor—you feel fine. Later you have dizziness, a headache, forgetfulness, and a lack of concentration. That's a concussion—your brain went slamming into your skull, causing a disruption in normal brain activity.

Concussions have long been regarded as just "part of the game," especially when it comes to sports such as football and soccer or military personnel in combat. Players and coaches have historically agreed that you can't separate violence from football. As a result, athletes think they know what they are risking when they hit the field—torn ACLs and broken bones, for example. But do they really know what they are risking with blows to the brain?

The immediate symptoms can range from minor to more serious, but no one seems to know for sure what long-term effects concussions have—especially when it comes to repeated concussions. According to a Boston University study, a growing body of evidence suggests that repetitive head trauma may increase the risk of a variety of progressive brain disorders, including Alzheimer's, Parkinson's, and the muscle-wasting condition amyotrophic lateral sclerosis — otherwise known as ALS or Lou Gehrig's disease.

"One of the most challenging aspects of treating concussions is diagnosing the part of the brain that has been damaged."

Dr. Thomas Talavage

The alarming reality

Ponder this: The Centers for Disease Control and Prevention (CDC) estimates there are 3.8 million sports- and recreation-related concussions per year, among all ages. The potential long-term impact of jaw-dropping collisions in sports has become a hot-button issue with the National Football League (NFL) this season. Multiple concussions have ended the careers of many star players, including NFL Hall of Fame quarterbacks Steve Young of the San Francisco 49ers, Troy Aikman of the Dallas Cowboys, and three-time Super Bowl champ linebacker Ted Johnson of the New England Patriots.

The news does not get better for student athletes. A 2007 CDC report estimated there are 135,000 emergency room visits per year for traumatic brain injuries among people ages five to 18, the majority coming from recreational sports.

Additionally, the Concussion Clinic at Nationwide Children's Hospital in Ohio estimates 400,000 concussions occurred among 7.5 million student athletes who participated in high school sports during the 2008-2009 school year. Furthermore, a recent clinical study by the Children's National Medical Center in Washington found that more than 80% of student athletes who experienced concussions reported a significant worsening of symptoms over the first four weeks after attempting to return to school academics.

Even after recent media coverage about this "silent epidemic," awareness remains lacking. For every star player who gets media time as a result of a concussion, there are thousands of players, parents, coaches, and even medical personnel who may be underplaying these jarring hits—possibly due to a lack of knowledge.

While concussions are routinely accepted as "part of the game," many of them go undiagnosed. Concussions among high school athletes occur with alarming frequency, although it's impossible to know exactly how often because of gaps

Purdue University photo/Andrew Hancock

Figure 1. Dr. Talavage, (left), and biomedical engineering doctoral student Evan Breedlove monitor impact data from high school football players. Recent research findings suggest many high school football players suffer undiagnosed changes in brain function and continue playing even though they are impaired.

Purdue University photo/Andrew Hancock

Figure 2. Dr. Talavage, who is also a founding co-director of the Purdue MRI Facility, prepares to test a Jefferson High School football player with Breedlove. The research examines how impacts to the head affect brain function.

in how the injuries are reported. There are those who might not believe all concussions can be eliminated—but they feel it's an issue worth fighting through prevention, diagnosis, and treatment.

"One of the most challenging aspects of treating concussions is diagnosing the part of the brain that has been damaged," says Thomas Talavage, PhD, an Associate Professor at the School of Electrical and Computer Engineering and the Weldon School of Biomedical Engineering at Purdue University.

A better way to study the injury and optimize therapies

Typically, doctors do not see athletes until after they are injured, having no idea what is normal for them. As a leader in MRI—and a believer in prevention—GE Healthcare collaborated with Purdue University to establish a platform to provide longitudinal data from "healthy through injury and recovery" on a high school football team. The study was largely funded by the Indiana Spinal Cord and Brain Injury Research Board.

Developed at Purdue University with Jefferson High School (Lafayette, IN), the study is advancing the understanding of concussions by providing a non-invasive in vivo method to study these injuries. It is an important step in improving knowledge of brain injuries and should lead to improved return to play and life, better therapies, and better guidance to protective equipment design and proper play techniques.

"It is hard to study the brain. We always do it after an injury or tragedy, so we rarely know what the brain looked like before the injury. There is rarely a baseline to use as comparison," says Jonathan Murray, General Manager in Cross Business Programs at GE Healthcare. "There is a lack of knowledge in diagnosis and treatment of brain injuries. To better understand brain injury and optimize recovery methods is critical."

First of its kind study

The first-year, groundbreaking study focused on collisions to the head in 21 high school football players over the course of a full season. This was the first study to combine MRI, functional MRI (fMRI), biomechanical monitoring, and cognitive testing at multiple times before, during, and after the season to evaluate the effects of hits to the head—including those not leading to a concussion.

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There were four stages to the study: Baseline assessment, in-game monitoring, in-season follow up, and post-participation follow up. Baseline MRI and fMRI readings were taken before the season started using the Signa† HDx 3.0T from GE Healthcare. All hits to the head exceeding 14.4 Gs were then recorded—using monitoring equipment inside the helmets—throughout the season. Based on the number or the magnitude of hits to the head they had experienced, 11 of the 21 participating players were invited back for additional tests during the season. Ten of these 11 players then underwent a post-season assessment, several weeks after the end of the football schedule.

Roller-coaster force results

The results, published in the Journal of Neurotrauma, are very insightful:

- Of the 21 high school players, four players who were never diagnosed with concussions were found to exhibit brain impairment that was at least as bad as that of other players who had been deemed concussed and removed from play.
- This impairment—observed in players who showed no symptoms of concussion—included significant performance drops on routine cognitive tests and decreased activity during fMRI in parts of the players' brains associated with working memory.
- Multiple players received more than 1,800 hits to the head during practices and games, some with a force 20 times greater than what a person would feel while riding a roller coaster.

"They're not exhibiting any outward sign and they're continuing to play," says Dr. Talavage, the lead researcher on the study. "The cognitive impairment that we observed with them is actually worse than the one observed with the concussed players."

What's next?

The study shines a light on injuries that have a potential to be more treacherous than full-blown concussions because they don't always result in outward symptoms, leading to players continuing participation. The concern is that these injuries could add up to cause serious long-term cognitive problems. "Our key finding is a previously undiscovered category of cognitive impairment," comments Dr. Talavage.

The study has been featured on the cover of Sports Illustrated and by other well-regarded media outlets such as NBC, ABC, FOX, CBS, CNN, ESPN, and CSPAN; the Chicago Tribune: National Public Radio; and The New Yorker. More media attention is expected as this hot-button topic continues to be discussed.

While there is no way to stop concussions from occurring, studies such as this can help determine, "What is normal for you?" and "What kind of concussion do you have?" With a healthy baseline to which the injury can be compared, the best treatment can be selected.

"GE Healthcare wants everybody to be active, healthy, fit, and safe—but when head injuries occur, we want to help doctors, patients, and parents feel confident about the best treatment option. We feel that starts with longitudinal studies," concludes Murray.

As the study moves into year two, plans are to repeat it while adding in a second high school (possibly with more teammates), to expand to other sports, and potentially to follow players over time, including at the collegiate level.

For more information about the Purdue Acute Neural Injury Consortium, a collaborative neurotrauma research group that combines expertise in clinical diagnosis and care, biomechanics, and neuroimaging, please visit **http://spin.ecn.purdue.edu/panic**. ■

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