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HEAR THE NEW SOUND OF PATIENT COMFORT.

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WELCOME

Dear Friends –

It is with pleasure I present you with the latest issue of SIGNA Pulse of MR. Last fall, as a crown jewel in our mission of Humanizing MR, we debuted our Silent Scan‡ technology at RSNA to over 4,000 visitors. Since then, over 1,000 visitors experienced Silent Scan at Arab Health in Dubai, and another 1,000 visitors at the European Congress of Radiology (ECR) in Vienna. All with incredibly positive reactions to this truly innovative technique.

Our patient-centric mission has been resonating with the healthcare community throughout the world. Facilities are embracing our Caring Design MR scanners, as well as the Caring MR Suites. The appeal of these innovations, as with many of our advancements, is that they are designed to benefit the patient and all those involved in the patient's journey.

There are many stakeholders in that journey. They include the referring clinician, the technologist, the radiologist, and the hospital administrator. To truly Humanize MR, we focus on the specific challenges of each stakeholder and determine how to best address their problems.

Take for example the difficulty of obtaining high-quality diagnostic images in the presence of MR conditional metallic implants. With the rapidly growing elderly population, the number of joint implants are growing and orthopedic surgeons are looking for ways to quickly and cost-effectively image around metal, to ascertain that the implant is still viable. Our answer, MAVRIC SL, significantly reduces distortions caused by metal and allows evaluation of the quality and functionality of replacements proactively and non-invasively.

Another advancement, the Needle-Free Suite of MR applications, helps address the pain points of technologists. By reducing the need for needles during procedures, we help technologists streamline workflow and lessen the need to reassure patients during a scan.

And then there's Silent Scan‡, of which I am most proud. Silent Scan has the potential to transform the entire MR experience. Because calm patients are less likely to move, this technology could result in shorter scan times, but I believe it is the patient who doesn't have to listen to a very loud scanner who will benefit most. If it isn't silent, it isn't cool.

So as we head to the 2013 ISMRM conference in Salt Lake City, Utah, we continue our theme of "Future focused. Patient centered." From a clinical perspective, this means that using the interests of patients and stakeholders as our guide, we continue to explore groundbreaking innovations. Take for example Traumatic Brain Injury (TBI).

With the ultimate goal of helping soldiers, accident victims, and athletes of all ages, GE has teamed up with the NFL to improve clinical understanding, diagnosis, and management of those suffering from head injuries (pages 50-51).

From a technical point of view, we focus on the future with our Parallel Transmit initiative, such as GE's MultiDrive technology, to develop fully integrated B1 shimming tools and algorithms to automate both the measurement and compensation of dielectric resonances at high fields.

As you read through the pages of this issue, you'll see more about what I believe is great technology. Technology that will help GE build the coolest MR brand on the planet as well as a compelling vision of putting the patient and the stakeholders first.

Good reading.

Jacques Coumans, PhD
CMO Global MR, GE Healthcare

‡ Not CE marked. Cannot be placed on the market or put into service until it has been made to comply with the Medical Device Directive requirements for CE marking.

WE WANT TO HEAR FROM YOU

The SIGNA Pulse of MR Editorial Board welcomes your feedback. In each issue, we'll feature a selection of reader comments on the magazine and questions about GE MR products and services. Write to us at signa.pulseofmr@ge.com.

Q I attended RSNA in Chicago last fall, and I heard about MAVRIC SL for imaging near MR Conditional implants. Our facility has a GE Discovery* MR750, and we see a lot of elderly patients with implants. I am interested in proposing looking into MAVRIC SL to my manager. Before approaching him, I have a few questions about the technology. For example, what is the weighting? Is it compatible with Fat Sat and IDEAL? What is the minimum FOV? Is MAVRIC SL good for routine imaging? And what are scan times like?

A Thanks for writing. We're excited about MAVRIC SL as well. Since RSNA, MAVRIC SL has received 510(k) clearance and is available for commercial use.

Now let's get to your questions. You asked about the weighting. Currently, the weighting is PD and STIR. Also, the current release is not compatible with Fat Sat and IDEAL.

The minimum FOV for MAVRIC SL is 12 cm for the Discovery* MR450 and MR750 and 18 cm for Optima* MR450w, Optima MR450w with GEM and Discovery* MR750w and MR750w with GEM.

Another thing you inquired about was if MAVRIC SL is good for routine imaging. The answer to that is no. MAVRIC SL is a specific sequence to be used in the presence of MR Conditional implants.

And as far as scan times go, you can expect about 4-6 minutes for a good SNR/matrix.

There is an entire article in this magazine devoted to MAVRIC SL. Please see page 42 for more information and for clinical images.

Cindee Guy
Marketing Specialist
MR Installed Base

Q My hospital currently has a Signa* HDxt 1.5T Optima* Edition 16.0. My manager just announced that we are upgrading to the Optima* Edition 23.0. What can I, as a tech, expect from this upgrade?

A As a tech, you can expect to get more from your scanner with the Optima Edition 23.0 upgrade. The upgrade includes more advanced applications and the latest workflow improvements.

As far as advanced applications go, this upgrade includes PROPELLER 3.0, which has expanded capabilities over the previous version. PROPELLER 3.0 can be used outside of the brain to significantly reduce the effect of patient voluntary and physiologic motion such as breathing, tremor, and flow, while also reducing magnetic susceptibility artifacts.

PROPELLER 3.0 is part of our Needle-Free Suite of applications, which focus on gaining clinical results with non-invasive procedures. MR Touch, another Needle-Free application, is a purchasable part of the upgrade. MR Touch is an elastography-based imaging technique that helps evaluate stiffness variations in liver tissue. Non-invasive, rapid, and radiation-free, MR Touch has the potential to aid early detection and to evaluate the whole organ for diffuse and focal liver diseases.

We also mentioned workflow improvements. The new user interface shared across Optima* and Discovery* product lines is designed to enhance productivity. The interface is easy to use, has time-saving features, and is designed to enhance communication between your team. For example, site protocols are easily saved, filtered, archived, and shared. You can automatically prescribe image processing and launch processing immediately after acquisition. And, protocol notes allow you to make notes for the benefit of others.

We think you'll love the Optima Edition 23.0 upgrade. It should allow you to see more, do more, and expect more from your scanner than ever before.

Cindee Guy
Marketing Specialist
MR Installed Base

MR NEWS

Silent Scan: the Buzz at RSNA

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The Radiological Society of North America (RSNA) conference is one of the most important forums for medical imaging innovations in the world. During RSNA 2012, GE Healthcare announced groundbreaking developments in MR that provide quality, affordable care to more people worldwide—underscoring the GE guiding principle of Humanizing MR.

Everyone was buzzing about the introduction of Silent Scan‡, revolutionary technology designed to address one of the most significant impediments to patient comfort—excessive acoustic noise generated during an MR scan. Conventional MR scanners can generate noise in excess of 110 dBA (decibels) levels, roughly equivalent to rock concerts. GE's Silent Scan technology is designed to reduce MR scanner noise to near ambient (background) sound levels and thus, can improve a patient's MR exam experience. The popular GE booth showcased the Caring MR Suite, featuring the Discovery* MR750w 3.0T, as well as a live demonstration of Silent Scan on the Optima* MR450w 1.5T: a real-time video link to a bay in Waukesha, Wisc., where technologists scanned phantoms to demonstrate the acoustic reduction and image quality. More than 4,000 visitors experienced the Silent Scan difference. See pages 36-41.

Another highlight was the unveiling of MAVRIC SL, an MR imaging technique for imaging patients with total joint replacements and other implanted devices. MAVRIC SL was designed in response to a growing clinical need for assessing soft tissue and bone on patients with MR Conditional implants, enabling diagnosis that is necessary to decide on a course of treatment. Previously, achieving diagnostic-quality images of the anatomy near to the implant was often extremely difficult in these patients. See pages 42-46.

Additionally, GE announced that the FDA recently approved a procedure that has been available in Europe since 2007 and is clinically shown to reduce pain from bone metastases—helping patients reduce their need for pain medication. ExAblate MR-guided Focused Ultrasound (MRgFUS) from InSightec Ltd. (Tirat Carmel, Israel), available on the Optima MR450w 1.5T and Discovery MR750w 3.0T wide bore systems, is providing new pain palliation for bone metastases patients. See pages 47-49.

Furthermore, GE introduced a Caring MR Suite designed and manufactured for the Optima* MR430s—a specialized extremity system that delivers high-quality 1.5T images. Patients sit on a padded, reclining chair and only the affected anatomy goes into the scanner. It's compact, installing in only 222 square feet. In collaboration with PDC Facilities, the Caring MR Suite helps further humanize the MR experience through the assuring senses of sight, sound, and touch. Via an intuitive interface custom built for the iPad, patients are able to choose from one of 16 different themes featuring mood lighting, music, and high-resolution nature photography. S

DIGITAL DIVE
Click here to watch a Silent Scan noise comparison video
tiny.cc/sps131

GE's Largest Presence at Arab Health

(From left to right) Richard Hausmann (GE MR's President and CEO)
Abdul Rahman Mohammed Al Owais (UAE Minister of Health)
Tom Gentile (SVP, President & CEO, Healthcare Systems)

This year marked GE Healthcare's largest presence at Arab Health—the Middle East's premier healthcare exhibition and conference. The company showcased its comprehensive range of Humanizing MR solutions designed to complement and build upon the region's current focus of promoting an earlier model of healthcare, through timely and accurate diagnosis.

The conference opened with Silent Scan‡, revolutionary technology designed to address one of the most significant impediments to patient comfort—excessive acoustic noise generated during an MR scan (see pages 36-41).

Visitors experienced a live, real-time video link to a bay in Waukesha, Wisc., where technologists scanned phantoms to demonstrate the acoustic reduction and image quality. Silent Scan drew about 1,000 visitors over the course of the show.

This was followed by the unveiling of the new Optima* MR360 Advance by GE MR's President and CEO, Richard Hausmann with the assistance of the Minister of Health, Abdul Rahman Mohammed Al Owais. The system fulfills the needs of facilities and patients by bringing into balance the advanced MR platform, combined with flexibility and efficiency. It provides exceptional performance, a comforting design, and advanced clinical applications. Two of its most compelling features are the Needle-Free Suite of MR applications and the 16-channel head and neck array.

Throughout the week, hundreds of attendees visited the MR section of the GE booth, including Sheikh Mohammed Bin Rashid Al Maktoum, Vice President of UAW and Ruler of Dubai and his wife, Princess Haya Bint Al Hussein, as well as the ministries of health from Dubai, Abu Dhabi, Qatar, Bahrain, and Oman.

DIGITAL DIVE
Click here to view a customer testimonial video
tiny.cc/sps132

ECR Booth Emphasized Humanizing MR

The 2013 European Congress of Radiology (ECR), which attracted more than 20,000 healthcare professionals and key opinion leaders from over 100 countries, is well-known as one of the most revolutionary meetings within the scientific community. The trend-setting, dynamic, and service-oriented congress provided the ideal backdrop for GE Healthcare to emphasize its Humanizing MR mission.

Many advanced technologies were featured at the company's popular booth, including Silent Scan‡, revolutionary technology designed to address one of the most significant impediments to patient comfort—excessive acoustic noise generated during an MR scan (see pages 36-41). Almost 1,000 visitors experienced a live demonstration of Silent Scan via a real-time video link to a bay in Waukesha, Wisc., where technologists scanned phantoms to demonstrate the acoustic reduction and image quality.

Other featured technologies included the Optima MR360 Advance, which enhances productivity and performance with the latest technology and patient-centric design (see pages 18-21), and the Optima MR430s, a specialized extremity MR system that delivers high-quality 1.5T images and patient comfort (see pages 29-31).

Additionally, in response to the industry's needs for user-friendly functionality and enhanced workflow efficiencies—combined with caring designs for greater patient comfort—GE Healthcare lead a scientific symposium titled, "Writing a New Chapter in the MR Book." Speakers discussed innovations such as silent MR technology and MAVRIC SL (see pages 42-46) that reinforce Humanizing MR.

GE Partners With NFL to Tackle Concussions

At the press conference for the Head Health Initiative in New York, NY, are Sholom Ackelsberg, Robert Wawrzyn, Roee Lazebnik, Mark Phillips, Baldev Ahluwalia, Curtis Brueske, Laura MacGuire, and Jonathan Murray.

The Centers for Disease Control and Prevention estimates that 1.7 million Americans suffer from a traumatic brain injury (TBI) every year.[1] Prompt diagnosis and response may help prevent serious injury in the future. However, many victims do not lose consciousness or show acute signs of trouble.

That's why GE and the NFL launched a $60 million initiative designed to speed diagnosis and treatment for TBI and stimulate new research and innovation in the field. "For all the advances in science, what we know today about the brain is decades behind our understanding of nearly every other organ in the body," says Jeff Immelt, GE Chairman and CEO. "With this collaboration, we will advance our research and apply our learning to sport-related concussions, brain injuries suffered by our soldiers, and neurodegenerative diseases such as Alzheimer's and Parkinson's. Advancing brain science will help families everywhere."

The initiative, called Head Health Initiative, has two core parts. The first is a four-year, $40 million clinical research and product development program that will optimize tools for looking at key MRI biomarkers in the brain that signal concussion, help improve diagnosis, and guide therapy. The second is a two-year innovation challenge that will invest up to $20 million, helping researchers working on "disruptive solutions" for diagnosing brain trauma and improving brain health. A 10-member medical advisory board will guide the research.

1. CDC. Injury Prevention & Control: Traumatic Brain Injury. Retrieved April 1, 2013. http://www.cdc.gov/traumaticbraininjury/index.html

Newly FDA 510(k) Cleared

- Silent Scan‡, revolutionary technology designed to address one of the most significant impediments to patient comfort—excessive acoustic noise generated during an MR scan. See pages 36-41.
- Two new 1.5T MR systems, the Optima MR360 Advance and Brivo MR355 Inspire, address the demand for increased patient comfort, increased productivity, and reduced total cost of ownership. For more information: **tiny.cc/sps133**.
- Two new cardiovascular MR analysis software packages for advanced analysis of cardiovascular MR images—CardiacVX and VesselIQ Xpress. For more information: **tiny.cc/sps134**.
- A new GEM RT Open Head & Neck Suite is designed to provide high-resolution, full field-of-view head and neck imaging in the presence of radiation therapy positioning devices and thermoplastic masks. For more information: **tiny.cc/sps135**.

Her Majesty the Queen Opens New GE MR Suite

Her Majesty The Queen opens new MRI Suite at The Queen Elizabeth Hospital, King's Lynn, UK.

In February of 2013, Her Majesty The Queen opened a £3 million MR suite housing two new GE Healthcare MR scanners at The Queen Elizabeth Hospital, King's Lynn, UK. The facility is expected to help significantly improve local diagnostic facilities for patients. The two installed scanners, the Optima MR360 1.5T and the Optima MR450w 1.5T with GEM Suite, will help increase capacity for scans predicted to increase from an annual 6,600 in 2008 to 13,000 per annum within the next few years.

Barbara Cummings, Director of Planning and Performance at The Queen Elizabeth Hospital King's Lynn NHS Foundation Trust, said, "We chose GE Healthcare technology for our new MRI scanner suite, as we have been impressed by the quality of the images their scanners produce and the more relaxed patient experience they allow. The Optima MR360 and Optima MR450w will also make it possible to carry out breast and heart scans, significantly improving the diagnostic facilities for patients in this area."

Two Global Firsts for GE MR

GE Healthcare will host its first MR Global Field Applications Summit starting May 6, 2013. During the week-long event, application specialists, clinical scientists, clinical sales support members, and applications development teams from around the world will gain a deeper understanding of GE systems and best practices. In addition to a two-day, hands-on training session, the summit offers lectures from PSD developers, ASL scientists, and other engineering teams.

Furthermore, in 2013, GE Healthcare will host the GE MR Factory—similar to Andy Warhol's Factory, the hip meeting place for creative artists, musicians, and free thinkers. The event will bring together radiologists, physicists, and technologists from across the globe to discuss GE imaging techniques, best practices, revolutionary ideas, and advances in MR. Visit www.gehealthcare.com/MRFactory.

GE and TUM Collaborate on Advanced MR Imaging

As part of a new diagnostic imaging laboratory at the prestigious Technical University Munich (TUM) in Munich, Germany, GE and the TUM recently launched a new MR laboratory with a Discovery MR750w 3.0T scanner to perform collaborative research to advance the state of diagnostic MR imaging technology. The Grand Opening Ceremony for the new MR lab was held in January, 2013.

Researchers at the Institute of Medical Engineering at the TU Munich (IMETUM), under the distinguished direction of Professor Axel Haase, will partner with scientists from GE Global Research and GE Healthcare to target some of the most challenging demands in diagnostic MRI. The unique combination of the strong technical expertise at IMETUM and at GE Global Research with the in-depth understanding of the customer needs at GE Healthcare will provide the grounds for successful partnerships in key clinical applications, such as imaging of cardiovascular, neurodegenerative, or metabolic diseases.

Grand opening ceremony for the new Discovery MR750w 3.0T scanner at the TUM, with prominent speakers from academia and the MR industry.

GE MR Unveils New Visitor Center

A redesigned GE MR Customer Information Center (CIC) in Waukesha, Wisc. is open for business. It accommodates customers in three spectacular MR bays: one for the Discovery MR750w, one for the Optima MR450w with GEM, and one for the Optima MR430s. All of the MR systems are displayed in their own breathtaking Caring MR Suites, with a specially designed ante-room, including facilities for customers.

Upon entry, customers can choose a Caring Theme from an iPad coverflow menu, as if they were a patient. Each theme is a serene video or photo collage, with a soothing soundscape and all-embracing mood lighting. Customers can also play music from their iPod and view photos or videos from their iPad.

The CIC also features an eye-popping new conference room. Phase II will include a separate entrance for customers and world-class reception, dining, and conference areas.

MR ENTEROGRAPHY PROVIDES HIGH-RESOLUTION, DYNAMIC IMAGES FOR PEDIATRIC IBD PATIENTS

It's hard to imagine a three-year-old having an inflammatory bowel disease (IBD) such as Crohn's Disease or ulcerative colitis. But the reality is that the incidence of pediatric IBD is rising. IBD first presents in childhood and adolescence in approximately 20% of all cases. One North American study reported the incidence of IBD in Wisconsin children to be 7.05 per 100,000, with the incidence for Crohn's Disease being 4.56—more than twice the rate of ulcerative colitis (2.14).[1]

There are distinguishing features between early onset and adult onset IBD. For children, consideration must be given to the stages of development and how these stages impact disease presentation and management.[1]

Recent diagnostic improvements

Recent advances in diagnostics and therapeutics have improved the care provided to children with IBD.[1] Small bowel follow-through was traditionally considered the imaging gold standard. However, according to Daniel Podberesky, MD, Associate Professor, and Chief,

Thoracoabdominal Imaging Division at Cincinnati Children's Hospital Medical Center in Cincinnati, Ohio, the procedure has significant limitations.

"Small bowel follow-through is a lumenagram of the bowel. You're not directly looking at the tissue being affected by the inflammatory bowel disease, which is the wall of the small bowel and other structures within the abdomen," he says. "It was always an indirect way of looking at the disease. Plus, small bowel follow-through takes a long time, patients don't like it, and radiologists find it burdensome. It was never a great study in the IBD setting."

For children with IBD, undergoing many CT scans by an early age is not uncommon. However, the repeated exposure to ionizing radiation comes at theoretical risk. According to Dr. Podberesky, CT enterography became available in the mid 2000s. With this technique, patients drink a special contrast which distends the small bowel, and then a CT scan is performed. The IV contrast is timed to maximize the chances of visualizing active inflammation of the small bowel. "It caught on very quickly, before the big uproar about ionizing radiation exposure from CT caught significant traction. But then, people started to say, why can't we do this with MR and avoid the radiation exposure?"

Enter MR enterography

As a result, in the mid 2000s, Mayo Clinic (Rochester, Minn) and other hospitals started to do MR enterography on adults. The study can provide high-resolution, dynamic images of the bowel, including dynamic motility images, without exposing the patient to ionizing radiation. The exam is often used to identify and locate inflammation, bleeding sources, lesions, abscesses, fistulas, and obstructions. The patient fasts for six hours, but can drink sweet liquid to prevent dehydration and hypoglycemia, and receives an IV antispasmodic to slow bowel motion. The technologist often positions the patient prone on the table to minimize motion artifact and decrease coronal scan durations.

For pediatric work, MR enterography really caught on. Cincinnati Children's started performing the exam in 2009, and it skyrocketed. The number of MR enterographies performed on a GE MR Signa* HDxt 1.5T 16-channel over the last three to four years has grown exponentially each year (0 in 2008 to nearly 300 in 2012). Dr. Podberesky attributes this growth to several things: The risk of ionizing radiation and sedation is reduced; the study provides essential information to the caring clinicians; and Cincinnati Children's inflammatory bowel disease center has grown rapidly in recent years.

"MR enterography serves as a great preliminary test not only for children who may have suspicion of IBD, but also for kids and teens who walk around every day with chronic abdominal pain from an unknown source," comments Dr. Podberesky. "The study serves that patient population very well; it can be done in 45 minutes and it can rule out IBD and other serious abdominal pathology. It makes parents, the patient, and the gastroenerologist feel better that this is not IBD or other serious abdominal pathology—it's likely just functional abdominal pain."

Dr. Podberesky says the technologists at Cincinnati Children's have gotten very comfortable with doing MR enterography. There haven't been any issues, except for the occasional child who gets nauseous from the glucagon. "There are really no complaints. If you talk to any of these teenagers with inflammatory bowel disease, they all would rather have the MR enterography compared to a small bowel follow-through—it goes quicker, the contrast they drink tastes better, and it's less difficult for them logistically."

He continues, "With MR enterography, radiologists don't have to spend an entire morning performing a small bowel follow-through study. It has been a really impressive modality for us here."

"MR enterography serves as a great screening test not only for children who may have suspicion of IBD, but also for kids and teens who walk around every day with chronic abdominal pain from an unknown source."

Dr. Daniel Podberesky

Figure 1. Axial post-contrast fat-supressed T1 weighted MR image in a teenager with Crohn's Disease demonstrates marked perirectal inflammation with a perianal fistula.

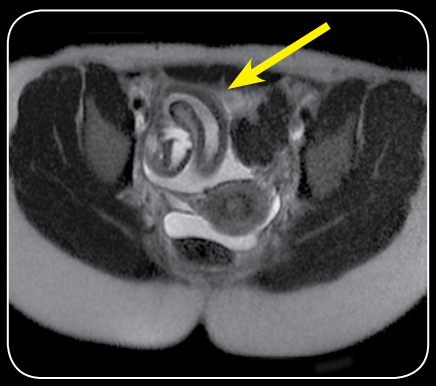

Figure 2. Axial SSFSE T2 weighted MR image in the same patient demonstrates bowel wall thickening in the terminal ileum and free fluid.

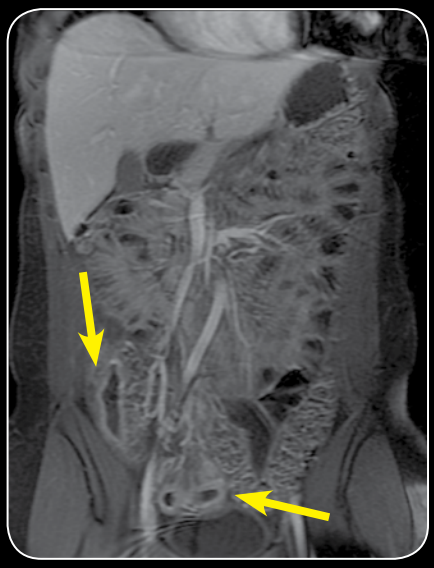

Figure 3. Coronal post-contrast fat-supressed T1 weighted MR image in the same patient demonstrates mucosal hyperenhancement involving the distal and terminal ileum.

Impacting patient care

Prior to MR and CT enterography, Dr. Podberesky says there was no reliable imaging modality that could provide objective information on whether or not IBD medications were working. The enterography exams have changed the way the gastroenterologists treat patients; for example, to gauge if a medication is working, they'll order an MR enterography to see if the inflammation has decreased. Gastroenterologists at Cincinnati Children's feel the exams have completely changed the paradigm on how they approach a new patient who is suspected of having IBD and an already-established IBD patient.

"We hear all the time from our gastroenterologists and surgeons that they really rely on MR and CT enterography results to decide on patient care and treatment options, and to guide discussions with kids and their parents on prognosis and what they can expect in the future," comments Dr. Podberesky.

There are many other situations where MR enterography at Cincinnati Children's benefits pediatric patients, such as children who had CT or MR enterographies performed previously at an outside institution and the parents are looking for a second or third opinion. Additionally, a child might have been diagnosed with Crohn's Disease, based on a small bowel follow-through, but after MR enterography it turns out to be normal—or vice versa. Furthermore, a child with known Crohn's Disease might appear to have the disease under control, but the doctor wants a baseline of how the bowel looks.

Understanding the nature of IBD—whether chronic or acute—in children is also important for treatment options. Ultimately, almost all Crohn's and ulcerative colitis patients will eventually need surgery. But it is critically important to be able to distinguish actively inflamed bowel versus chronically fibrosed and strictured bowel because the treatment is different. Dr. Podberesky explains, "We don't want to send a child for bowel resection and have the specimen come back and it wasn't chronically fibrosed; rather, it was just actively inflamed and could have been treated medically. Unfortunately, we're still not 100% accurate at determining active versus

Daniel J. Podberesky, MD

is Associate Director, Clinical Services, Chief of the Thoracoabdominal Imaging Division, and Associate Professor, Department of Pediatric Radiology, Cincinnati Children's Hospital Medical Center.

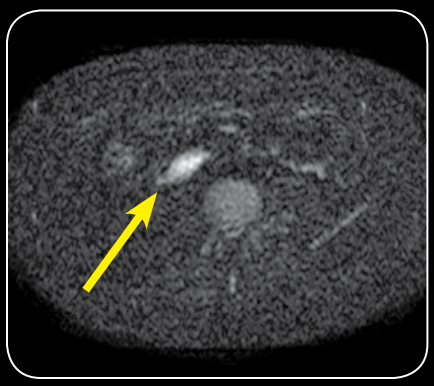

Figure 4. Axial diffusion-weighted MR image (DWI) in a teenager with Crohn's Disease demonstrates a focus of diffusion restriction in the right lower quadrant.

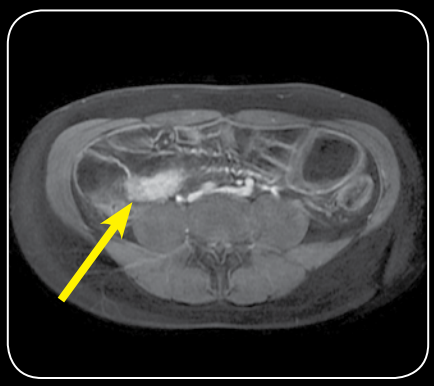

Figure 5. Axial post-contrast, fat-supressed T1 weighted MR image in the same patient at the same level as the DWI image demonstrates hyperenhancement of the terminal ileum correlating with the focus of diffusion restriction.

Figure 6. Coronal SSFSE T2 weighted MR image in the same patient demonstrates wall-thickening and luminal narrowing of the terminal ileum.

chronic inflammation, which is why we are working on MR enterography techniques such as diffusion-weighted imaging to help guide this differentiation."

A promising future

Cincinnati Children's and other clinics are researching diffusion-weighted imaging (DWI) in conjunction with MR enterography. According to Dr. Podberesky, he and his staff have been especially impressed with their early experience with DWI with background suppression—a more robust body diffusion-weighted sequence which seems to thoroughly show areas of active bowel inflammation. There is promising literature coming out on kids and adults using DWI to find actively inflamed areas of diseased bowel versus chronically fibrosed areas of diseased bowel.

The hospital also performs dynamic or cine peristalsis imaging of the bowel. This is a real-time sequence where one can see bowel motion, and find areas that are inflamed because those areas are not peristalsing normally compared to the adjacent normal loops of bowel.

Additionally, Dr. Podberesky says Cincinnati Children's is beginning to utilize image fusion techniques. "You can fuse DWI with post-contrast imaging, fuse MR enterography images with CT enterography, and you can even fuse PET images with CT or MR enterography. Fusing either within a modality or between different modalities is something that we're just starting to play with now, but I think it's a promising area for future research."

DIY

Dr. Podberesky shares advice for other hospitals and peers who are interested in implementing MR enterography. "The sequences themselves are not very difficult; the difficult part of the study is the logistics. My advice is to start somewhere and just do it. Once you do it and have good results, gastroenterologists will start asking for more."

References

1. Dubinsky M. Special issues in pediatric inflammatory bowel disease. World J Gastroenterol. 2008 January 21;14(3):413-420.

The radiologists at Cincinnati Children's frequently share their protocols with other institutions. Following is a portion of Dr. Podberesky's MR enterography protocol; to see it in its entirety, visit www.ncbi.nlm.nih.gov/pubmed/22520509.

	Pulse Sequence	Imaging Options	TE	TR	TI/flip	Bandwidth	FOV	Slice Thick/Gap	Matrix
Cor FIESTA MPh non BH	FIESTA	Seq, FAST, MPh, ZIP 512	min. full		45	125	var.	8/0	256 x 256
Use maximum # of phases, @ 25									
Ax SSFSE RTr	Spin Echo	Seq., RTr	140			62.50	var.	6 skip 1	320 x 224
Respiratory trigger window = 30; respiratory interval = 1; each additional slice adds time, but no limit on slices									
Cor SSFSE BH	Spin Echo	Seq., ASSET x 2	140	min.		62.50	var.	5/1	288 x 192
Ax FIESTA FS BH	FIESTA	Seq., ZIP 512, ASSET X 2	min. full		45	83.33	var.	6 skip 1	224 x 224
Locs before pause should equal one half the number of slices prescribed to get reasonable breath hold									
Cor FIESTA non FS BH	FIESTA	Seq., ZIP 512, ASSET X 2	min. full		45	125	var.	5/1	256 x 256
AX DWI	SPIN ECHO EPI	DIFF, ASSET x 2, PH CORRECT.	min.	3000			var.	5/1	192 x 128
Use b-values of 10, 100, 500, and 1,000; scan from just below stomach to mid/lower pelvis; adjust gap, not slice thickness									
Ax pre LAVA FS BH Ax post LAVA FS BH 120 second delay	LAVA	MPh, ZIP 2, ASSET X 2			12	83.33	var.	6.2	320 x 192
Scan superior to inferior; @ 60 locs/slab; BH time @ 20 secs									
Cor pre LAVA FS BH Cor post LAVA FS BH 60 second delay Cor post LAVA FS BH 180 second delay	LAVA	MPh, ZIP 2, ASSET X 2			12	83.33	var.	4	320 x 192
46 locs/slab; BH time @ 15 secs.									
Cor T1 post FSPGR FS BH 20 second delay	SPGR	ASSET X 2	min.	210	80	31.25	var.	5/1	352 x 192
BH time @ 22 secs.									

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Cincinnati Children's Hospital Medical Center *ranks third in the nation among all Honor Roll hospitals in U.S. News and World Report's 2012 Best Children's Hospitals ranking. It is ranked #1 for neonatology and in the top 10 for all pediatric specialties. Cincinnati Children's is one of the top two recipients of pediatric research grants from the National Institutes of Health. It is internationally recognized for improving child health and transforming delivery of care through fully integrated, globally recognized research, education, and innovation. Additional information can be found at www.cincinnatichildrens.org.*

SYSTEM UPGRADE EXPANDS CLINICAL CAPABILITIES WITH NEW MR TECHNOLOGY

Provides Advanced MR Applications, Improved Image Quality, More Accurate Diagnoses

Borromeus Hospital provides healthcare to residents in Indonesia's third largest city. With a population of 2.4 million, Bandung is the capital of West Java. After Indonesia regained independence in 1945, the city developed into a major urban center and today, it is a popular weekend destination for residents of Jakarta—known for its Dutch colonial architecture and factory outlet stores.

Installed in 2001, the Signa* LX was the second MR scanner implemented in the country. Chief Radiologist Tan Siauw Koan, MD, recognized as a senior consultant radiologist in oncology imaging throughout the region and has trained many of the radiologists in the country. He continues to lecture with the PDSRI/Radiology Society of Indonesia and provide MR training in Borromeus Hospital for both radiologists and radiographers.

To further enhance the imaging capabilities at Borromeus Hospital, Dr. Tan and his colleagues are currently considering purchasing a new 3.0T MR system. While contemplating the 3.0T MR purchase, Dr. Tan was also interested in replacing his aging 1.5T MR. However, with the construction of a new hospital wing, funds are limited and the facility cannot purchase two new systems.

"We would have to wait for more than 10 years to purchase a new 1.5T system in addition to the planned 3.0T system," Dr. Tan explains. He learned of another option that would provide him the best of both–GE's ContinuumPak. In August of 2012, Borromeus Hospital purchased an upgrade to take its Signa LX to the Signa HDxt Optima* Edition 23.0.

With the upgrade, Dr. Tan and his colleagues now have access to some of GE's most advanced MR applications, including 3D Cube for T1w, T2w FSE and FLAIR, SWAN, PROPELLER 3.0, DTI, LAVA Flex, IDEAL, Inhance, 3D ASL, MRA 4D TRICKS, MR perfusion, and eDWI.

"The image quality, including spatial and temporal resolution and signal-to-noise ratio (SNR), are far better than before," Dr. Tan says. "The new sequences provide a more comprehensive MR exam and the system is faster. With the

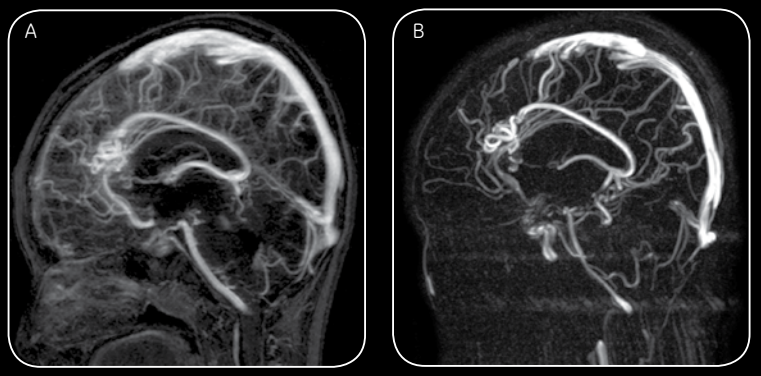


Figure 1. April, 2010: Contrast-enhanced MRA and 3D TOF (A) conducted on an eight-year old post craniotomy evacuation of spontaneous intracerebral hematoma with suspected frontal arteriovenous malformation (AVM). Nearly three years later, (January, 2013) same patient presented with headache, but was afraid of needle injection. With the Signa HDxt Version 23.0 upgrade, Borromeus Hospital now has the capability to conduct a needle-free MRA utilizing Inhance 3D Velocity and 3D TOF (B). Inhance produced comparable images to contrast-enhanced study that enabled the radiologist to determine the nidus of AVM looked stable. 3D TOF now provided stronger signal.

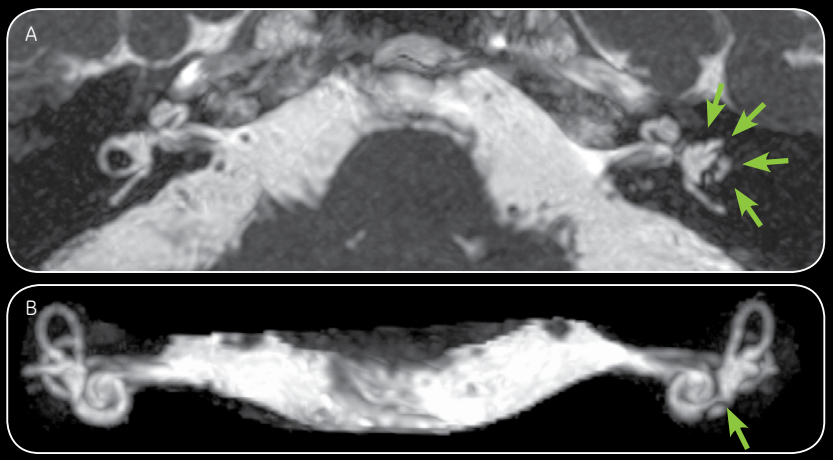


Figure 2. Patient presented with sudden deafness and history of blow to the right temple of the head. 3D FIESTA (A) with 0.8 mm slices was performed with MIP (B). Patient was diagnosed with left semicircular rupture and perilymph round-window fistula (green arrows).

upgrade, we can now offer patients higher quality and more variety in MR imaging, and of course this gives us a competitive advantage."

With an array of imaging sequences, Dr. Tan can generate a more complex exam for a more accurate diagnosis. In particular for brain tumors, Dr. Tan can perform MR spectroscopy, MR perfusion, DTI, and functional imaging. The hospital is also offering breast MR studies with high spatial and temporal resolution, DWI, water, silicone, and fat suppression. Radiographers are also pleased with the system's speed and shorter exam times, which are particularly impacted when utilizing the isotropic imaging capabilities of Cube.

"After the upgrade, we have many more options and flexibility than before, and this helps us to view and solve more problems than we could previously," concludes Dr. Tan.

Tan Siauw Koan, MD
is the Radiologist Consultant, Chief Radiologist, and Chief of Radiology Medical Staff in the Radioogy Department of St. Borromeus Hospital.

Tan Siauw Koan, MD, *is the Radiologist Consultant and Chief of Radiology on the Medical Staff of St. Borromeus Hospital in Bandung, West Java, Indonesia. He received his M.D. from Maranatha Christian University in Bandung in 1979 and his radiology degree from Padjadjaran University in Bandung in 1989. He held the position of Head of Radiology Department from 1992 to 2010 and Chief of Radiology Medical Staffs of St Borromeus Hospital from 1992 up to now. His professional interests include diagnostic radiology, conventional radiology, ultrasound, CT and MR imaging.*

Saint Borromeus Hospital *in Bandung, West Java, Indonesia, is the largest of all the healthcare facilities under the PPSB Foundation. The hospital was founded in 1921 by the Sisters of Charity Community Borromeus Carolus from the Netherlands. It is a highly recognized private hospital with more than 400 beds. The hospital is not only fully accredited, but is also one of a few hospitals that has received an ISO certification.*

NEW MR SYSTEM EXCEEDS EXPECTATIONS FOR HIGH-QUALITY IMAGING AND PATIENT COMFORT

Istanbul is one of the largest cities in the world with a population of 13.9 million people. The city is divided by the Bosphorus—or Istanbul Strait—one of the world's busiest waterways that connects the Sea of Marmara to the Black Sea. Istanbul is the only city in the world that sits on two continents: West of the Bosphorus is Europe, and the Eurasian Plate, while East of the Bosphorus is Asia, and the African Plate.

Healthcare in Turkey is primarily delivered through a centralized, state-run system run by the Ministry of Health. While private healthcare facilities and providers have delivered care for decades, a 2003 health reform package helped drive further growth in the private sector.

Sonomed Medical Imaging Centre and Laboratory is a private medical imaging provider with two facilities in Istanbul: one in the Kadıköy district and another in the Kızılay Altıntepe district. The organization also operates a third facility in İzmir Province. Sonomed offers digital mammography, digital X-ray, bone densitometry, ultrasound, nuclear medicine, PET/CT, and MR imaging. Services include interventional radiology in addition to diagnostic testing.

Each month in the Kadıköy facility, Sonomed conducts 750 MR exams on two 1.5T systems. One of these is a newly installed Optima* MR360 Advance, a premium 1.5T system designed to enhance a patient's MR experience while improving productivity and clinical confidence under the GE guiding principle of Humanizing MR. According to Zafer Kaya, MD, radiologist and administrator at Sonomed, the organization chose GE Healthcare for, "both the advanced technology and the approach of the GE team. The Optima MR360 Advance is the perfect fit for our center."

For the radiologists at Sonomed, it is the image quality and breadth of applications that sets the Optima MR360 Advance apart. Salih Güran, MD, radiologist says, "From the start, this system gave us the impression that it is an advanced and different MR system compared to older systems we've used."

A system that stands out

The installation process ran smoothly, explains Dr. Kaya, with the length of time required to install the system in line with his expectations. The Optima MR360 Advance occupies 35 square meters in the building, including the technical room. He was impressed with the GE team during the installation and found the applications training extremely useful and productive. Dr. Güran adds that the technologists have quickly adapted to the new user interface.

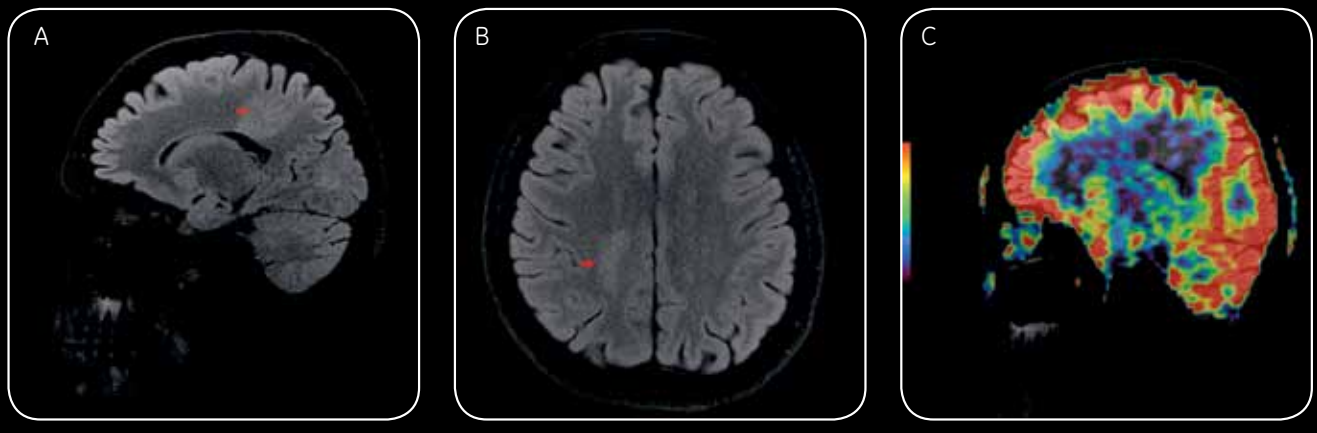


Figure 1. Sagittal T2 FLAIR Cube (A) with axial reformats; (B) demonstrates an area of hyper intense signal, indicating gliosis (red arrow). Correlating 3D ASL images fused to Cube FLAIR images in READY View; (C) demonstrates a subtle hypo-perfused region.

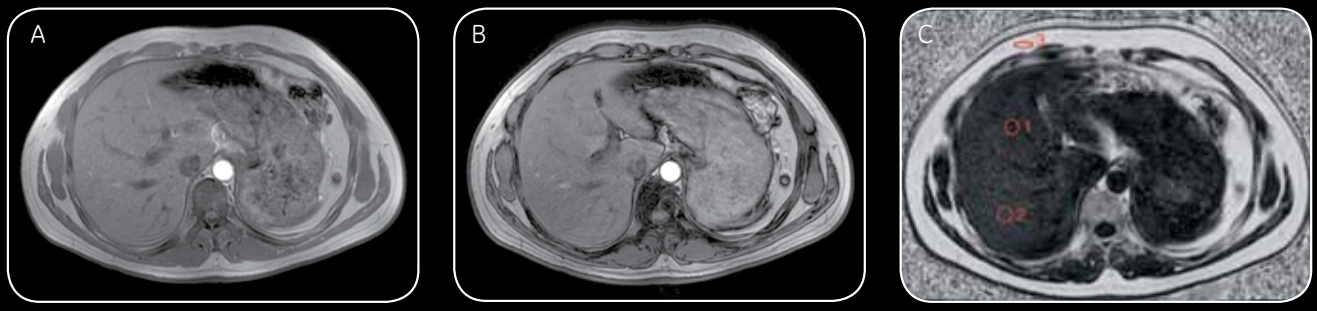


Figure 2. In-phase image (A); the out-of-phase image (B) shows mild heterogenous signal throughout the liver indicating patchy fatty infiltration (steatosis); IDEAL IQ allows quantification of fat by placing ROIs on the image (C). ROI #1 is 4% fat, ROI #2 is 15% fat, ROI #3 placed in the region of subcutaneous fat demonstrates 92% fat.

One aspect of the system's hardware that stands out is the OpTix Optical RF technology. Dr. Kaya notes that the OpTix RF technology increases the imaging quality and decreases the duration of the examinations, further enhancing clinical efficiency. "The imaging quality definitely exceeds our expectations, and for our physicians and patients, the highest priority is quality imaging and correct diagnoses." Dr. Güran adds that the stability of the device and the high performance sequences are particularly striking.

While high-quality imaging is a key requirement for Sonomed, patient comfort is invaluable. "We receive comments that the device is more comfortable than our previous MR scanners," adds Dr. Kaya. As a private provider, patients have a choice. The Optima MR360 Advance embraces GE's Caring Design concept that helps make MR more welcoming for the patient and intuitive for the technologist.

New sequences extend clinical services

"A good radiology practice requires full coherence with new and advanced medical technologies," says Dr. Güran. The Optima MR360 Advance fulfils this for Sonomed. "We believe that the performance and ease of use in the applications, such as MR Spectroscopy, MR Angiography, Functional MR, Diffusion MR, and other various technical applications will benefit our radiology department," he adds.

In addition to these MR capabilities, beginning in April, 2013, Sonomed will begin to offer new, routine services such as MR-guided breast marking and biopsy, and cardiac MR, including perfusion.

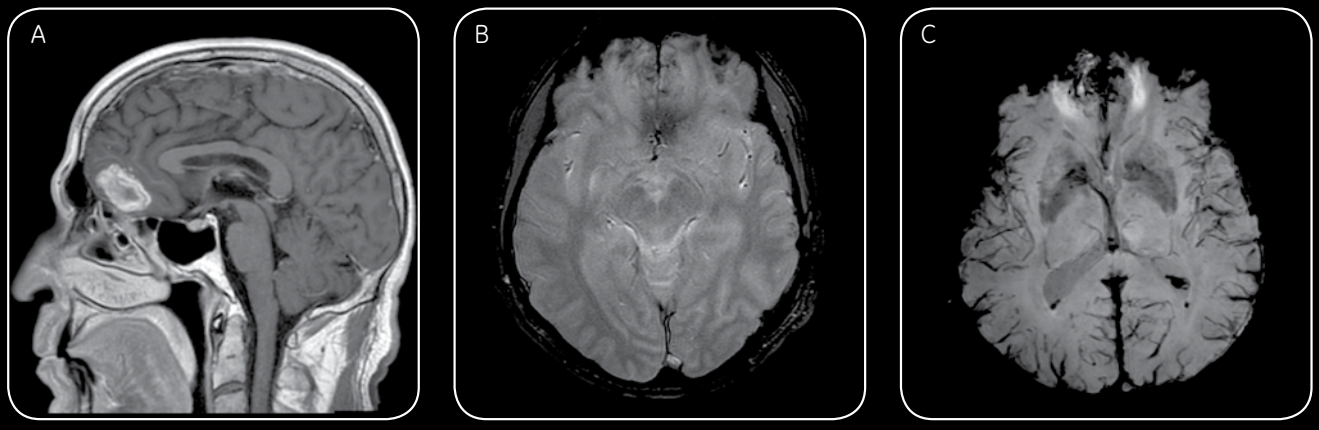


Figure 3. The Sagittal Cube T1 shows hyper intense signal in the frontal lobe (A); T2* GRE (B) demonstrates susceptibility effects in the frontal lobe; The SWAN image (C) provides improved visualization of the area while showing small vascular structures.

Patients benefit as well from advanced MR imaging, Dr. Güran explains. "The new generation non-invasive MR applications offer great benefits for the patients. For example, IDEAL IQ enables us to measure the fat percentage of the liver; 3D ASL gives us unenhanced and quantifiable brain perfusion information; and the new generation unenhanced MR Angiography sequence Inhance and other similar very powerful applications strengthen our diagnostic capabilities with minimal effect on the patients."

Dr. Kaya agrees, noting that, "The new applications provide a significant advantage for us in diagnosis. Needle-Free applications such as 3D ASL, Inhance, PROPELLER 3.0, IDEAL IQ, and whole body diffusion in oncology are a significant addition with respect to patient diagnosis."

The new MR system is playing an important role in the imaging success at Sonomed. Dr. Kaya believes that with GE's range of advanced applications, vision for humanizing MR, and pipeline of innovation, Sonomed is well-positioned to tap into future advancements. These are all key reasons why he and his colleagues selected GE as the organization's imaging partner.

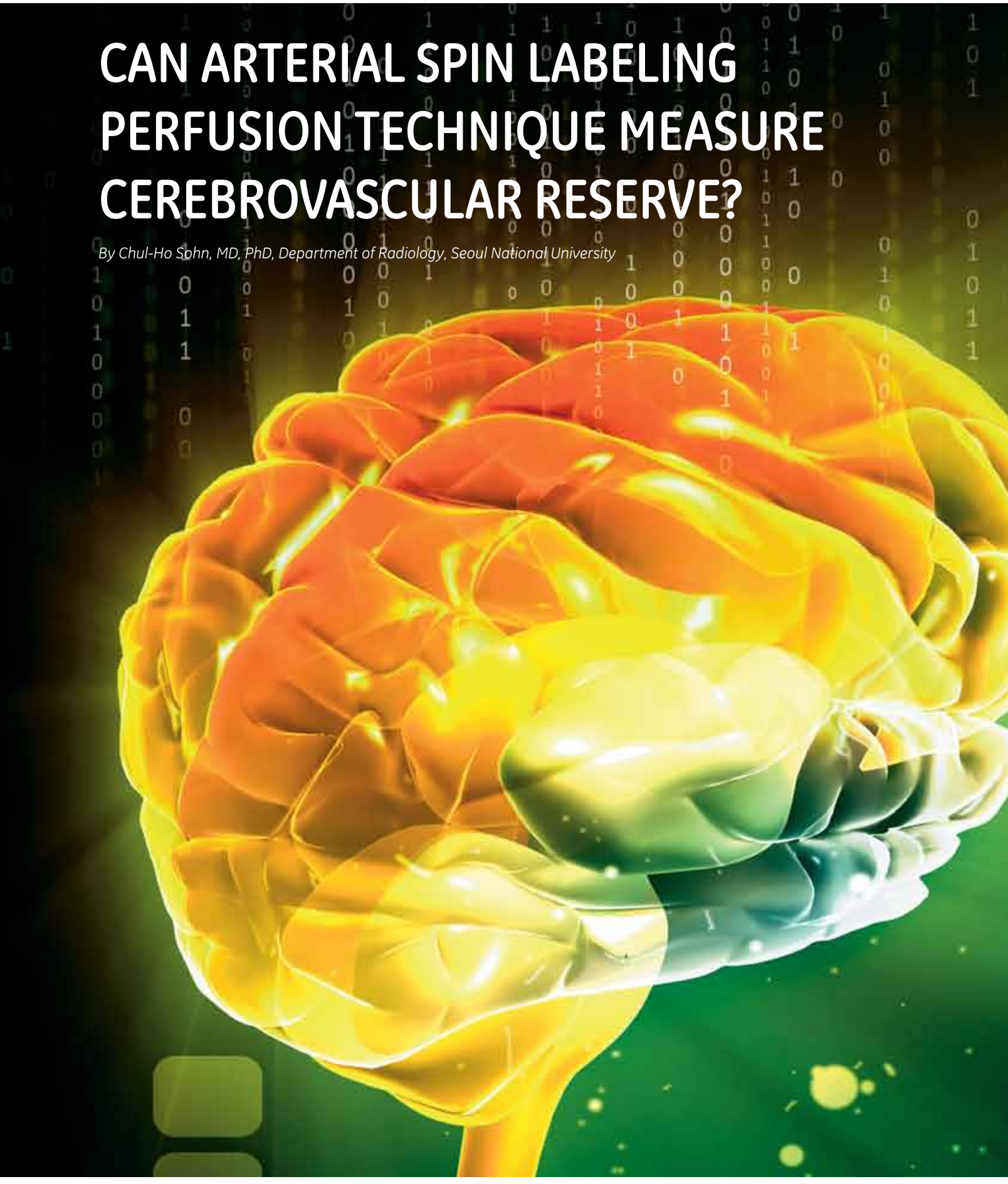
Zafer Kaya, MD, *is a radiologist and the Director of Sonomed Imaging Centre. He earned his medical degree from Antalya University Faculty of Medicine and completed his radiology residency at Atatürk Research & Education Hospital. Dr. Kaya has 25 years of experience in various radiology disciplines. Today, he primarily focuses on CT coronary artery imaging; peripheral, abdominal and musculoskeletal Doppler ultrasound; and spine and abdominal MR. He has co-authored several articles and book chapters on multi-slice CT coronary angiography imaging, coronary artery diseases, and the future of coronary CT.*

Salih Güran, MD, *is a radiologist, Director of Sonomed Imaging Centre, and an Associate Professor of Clinical Radiology. Dr Güran received his medical degree from Istanbul University, Istanbul Faculty of Medicine, and completed his radiology residency at Hacettepe University, Ankara, and an interventional radiology fellowship at Marmara University, Istanbul. He specializes in Body MR imaging and vascular and interventional radiology.*

Sonomed Medical Imaging Centre and Laboratory *is one of the first private radiology investments in Turkey, created in 1992. Sonomed is located on the Anatolian side of Istanbul, Kadıköy. The radiology department is equipped with two 1.5T MRI systems, including the new Optima MR360 Advance. Sonomed performs approximately 9,000 MR examinations each year. The radiologists at Sonomed have earned a reputation for diagnosing challenging cases by leveraging their expertise and the imaging capabilities from the Centre's continued investment in advanced technology.*

CAN ARTERIAL SPIN LABELING PERFUSION TECHNIQUE MEASURE CEREBROVASCULAR RESERVE?

By Chul-Ho Sohn, MD, PhD, Department of Radiology, Seoul National University



Chul-Ho Sohn, MD, PhD,
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Cerebrovascular reserve (CVR) is the vascular capacity to change the vascular tone, through vasoconstriction or vasodilatation, to maintain an adequate and constant oxygen delivery to the brain. The CVR reflects the brain's autoregulation capacity to increase the cerebral blood volume by vasodilatation in situations of cerebral perfusion pressure reduction in order to maintain a constant cerebral blood flow (CBF). CBF is a significant prognostic factor in chronic cerebrovascular disease.

Arterial spin labeling (ASL) perfusion technique is a non-invasive imaging tool that does not require any exogenous tracer. ASL has two major drawbacks. One is a poor signal-to-noise ratio (SNR). Pseudocontinuous ASL technique, however, almost overcomes this problem (Figure 1). The second is delayed arterial arrival time. The ASL technique is highly dependent on arterial arrival times, which is changed in people with chronic cerebrovascular disease, such as atherosclerotic stenosis of internal and external carotid artery, and Moyamoya disease.

Is ASL technique able to measure CVR in Moyamoya disease? In routine clinical practice, SPECT basal/stress (acetazolamide) is a widely available perfusion technique providing semi-quantitative measures of CBF and CVR in chronic cerebrovascular disease.

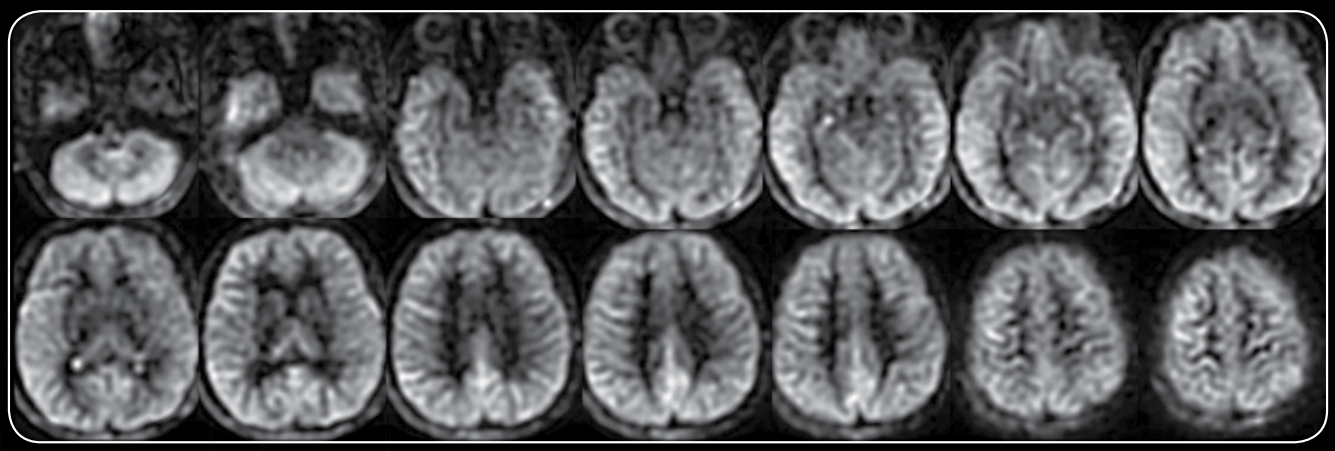

Figure 1. Normal volunteer, 25-years-old. Scanned on Signa* HDxt 1.5T MR. CBF maps using pseudocontinuous ASL, which demonstrates good SNR to clearly visualize cortical and white matter differences of CBF values.

In our practice, we have studied ASL as an alternative perfusion technique for measurement of CVR in Moyamoya disease (Figures 2, 3). The ability to measure CVR in this patient group is important for guiding patient management, particularly for surgical intervention and revascularization. We have found that ASL can identify impaired CVR with excellent performance and has the potential to serve as a non-invasive imaging tool for determining CVR in patients with Moyamoya disease.

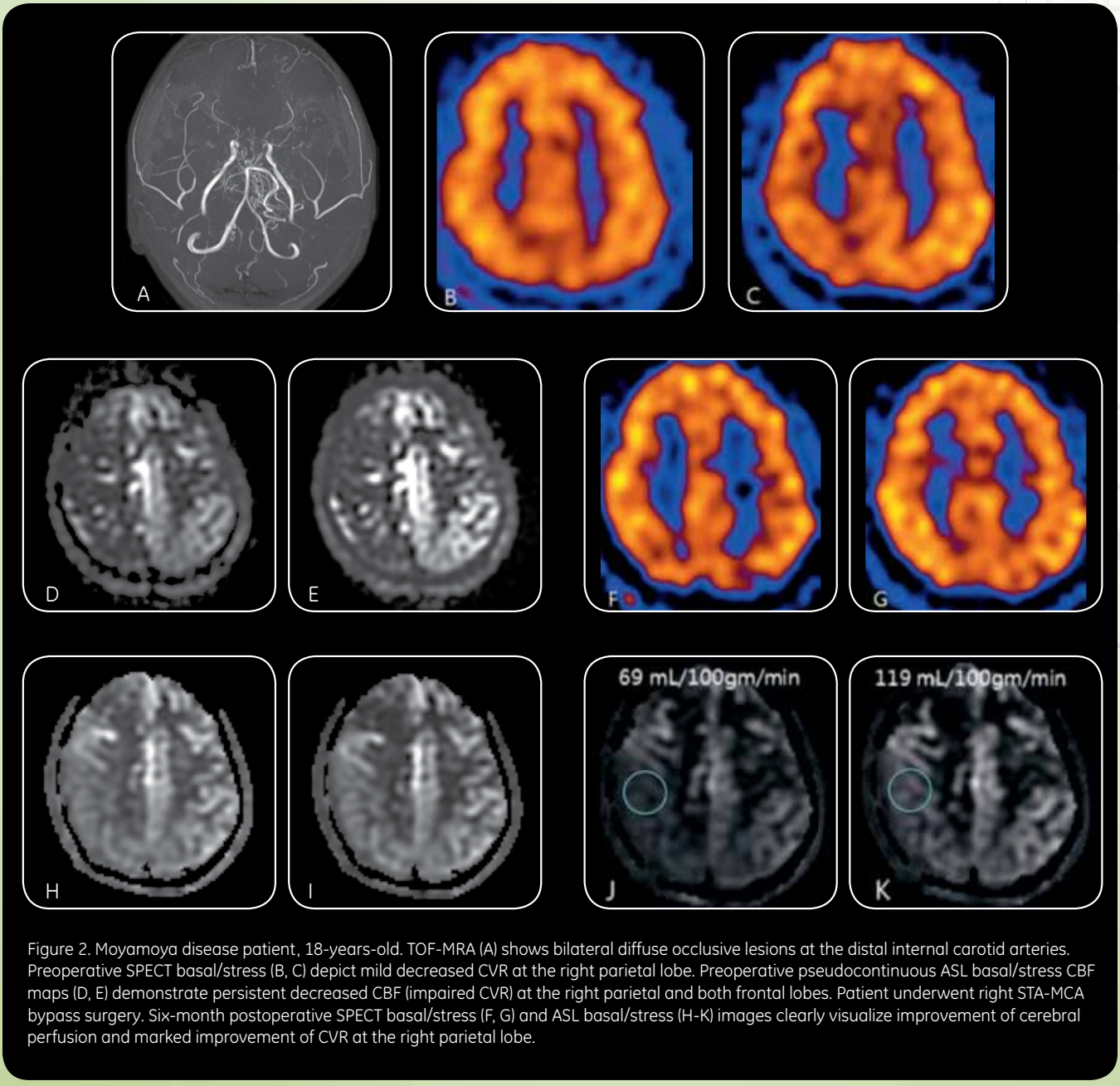

Figure 2. Moyamoya disease patient, 18-years-old. TOF-MRA (A) shows bilateral diffuse occlusive lesions at the distal internal carotid arteries. Preoperative SPECT basal/stress (B, C) depict mild decreased CVR at the right parietal lobe. Preoperative pseudocontinuous ASL basal/stress CBF maps (D, E) demonstrate persistent decreased CBF (impaired CVR) at the right parietal and both frontal lobes. Patient underwent right STA-MCA bypass surgery. Six-month postoperative SPECT basal/stress (F, G) and ASL basal/stress (H-K) images clearly visualize improvement of cerebral perfusion and marked improvement of CVR at the right parietal lobe.

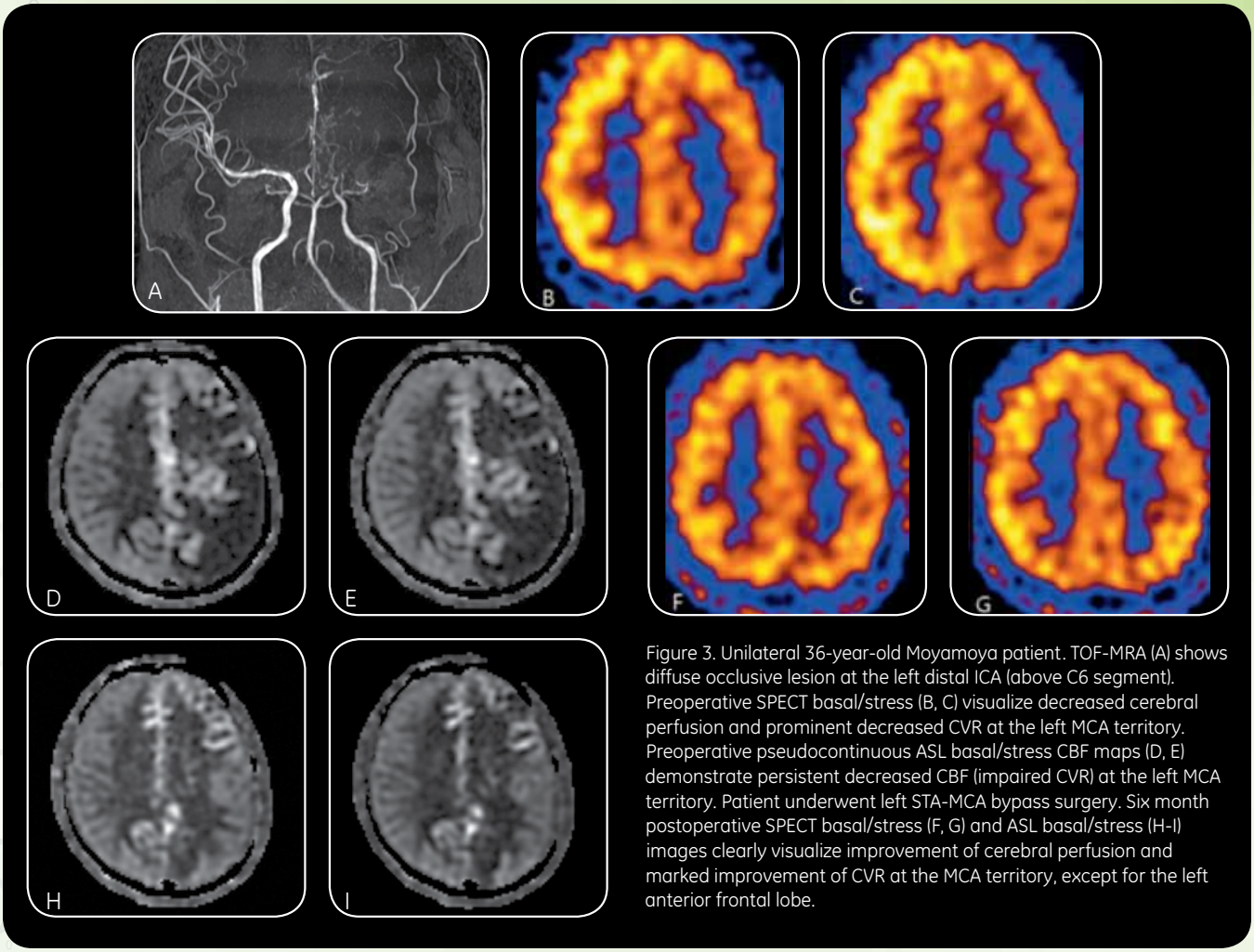

Figure 3. Unilateral 36-year-old Moyamoya patient. TOF-MRA (A) shows diffuse occlusive lesion at the left distal ICA (above C6 segment). Preoperative SPECT basal/stress (B, C) visualize decreased cerebral perfusion and prominent decreased CVR at the left MCA territory. Preoperative pseudocontinuous ASL basal/stress CBF maps (D, E) demonstrate persistent decreased CBF (impaired CVR) at the left MCA territory. Patient underwent left STA-MCA bypass surgery. Six month postoperative SPECT basal/stress (F, G) and ASL basal/stress (H-I) images clearly visualize improvement of cerebral perfusion and marked improvement of CVR at the MCA territory, except for the left anterior frontal lobe.

Vitals...

Moyamoya disease is a rare cerebro-vascular disease that primarily affects children, but can be found in adults. It is caused by blocked arteries in the basal ganglia, or base of the brain. Stroke, or recurrent transient ischemia attacks (TIAs) are often the first symptom, followed by muscular weakness, paralysis on one side, or seizures. Other symptoms include disturbed consciousness, sensory and cognitive impairments, speech deficits, involuntary movements, and vision problems. Treatment consists of several types of revascularization surgery to restore blood flow to the brain by opening the narrowed, or blocked, arteries. Without surgery, progressive narrowing of the arteries will occur and lead to mental decline, multiple strokes, and in some instances, death due to intracerebral hemorrhage.

Source: National Institutes of Health. http://www.ninds.nih.gov/disorders/moyamoya/moyamoya.htm

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Seoul National University Hospital's Department of Radiology *is committed to offering its patients the highest-quality care available through image-based patient care. The department is organized into 10 specialty divisions to provide exceptional patient care, research, and teaching.*

Clinical divisions are: breast imaging, cardiovascular radiology, chest radiology, gastrointestinal radiology, genitourinary radiology, emergency radiology, interventional radiology, musculoskeletal radiology, neuroradiology, and pediatric radiology.

Optima* MR360 1.5T

Non-contrast MRA of Renal Arteries, Lower Limb Arteries, and Veins Using Inhance

By Vijaya Bhaskar Nori, MBBS, MD, Director and Chief Radiologist, Vista Imaging & Medical Center, India

Patients with renal dysfunction are at an increased risk for complications due to the use of contrast in conjunction with CT or MR exams. Yet, these patients often require repeat or follow-up imaging studies to evaluate their kidney function, including the renal arteries. Historically, the use of contrast in CT or MR exams has been the standard of care. Contrast-induced nephropathy can be as high as 30% to 40% in patients with GFR <30 mL/min,[1] while Nephrogenic Systematic Fibrosis primarily occurs in 5% of patients with GFR <30 mL/min.[2]

Non-contrast enhanced MR Angiography (NCE-MRA) techniques, such as DeltaFlow, have been shown to provide excellent contrast between vessels and adjacent soft tissue. Two examples are NCE-MRA of peripheral arteries for lower limb ischemia and non-contrast MR venography (NCE-MRV) of lower limb veins. In our facility, we are utilizing non-contrast MR rather than CT due to the lack of ionizing radiation and ability to provide reproducible results in repeat patient studies.

MR technique

For non-contrast MRV:

- Applying the inversion pulse and Sat band in the direction of arterial flow (superior to inferior).
- Adjusting the acquisition volume to maximize flow signal from veins.

MR Parameters	
Non-Contrast Inhance Renal Angio	
Pulse Sequence:	3D Inhance IFIR
Imaging Options:	Fast, IrP, RT, ZIP 512, ZIP 2, Asset
Flip Angle:	70
TI:	Auto
Blood Suppression TI:	1200
Receiver Bandwidth:	125.00
Freq:	256
Phase:	224
Freq Dir:	R/L
Phase FOV:	0.75
Resp. Trigger Point:	10
Resp. Trigger Window:	30
View Order:	Bottom/Up
Non-Contrast Inhance Peripheral Angio Artery or Veins	
Pulse Sequence:	2D Inhance IFIR
Imaging Options:	FC, Gat, Seq, Fast, ZIP 512
Flip Angle:	65
TR:	Minimum
TE:	Minimum
Receiver Bandwidth:	125.00
Freq:	256
Phase:	192
Freq Dir:	R/L
Phase FOV:	0.50
Minimum Trigger Delay:	1
Views per Segment:	32
View Order:	Bottom/Up

Vijaya Bhaskar Nori, MBBS, MD
is the Director & Chief Radiologist of Vista Imaging & Medical Centre, Hyderabad, AP, India.

Case 1

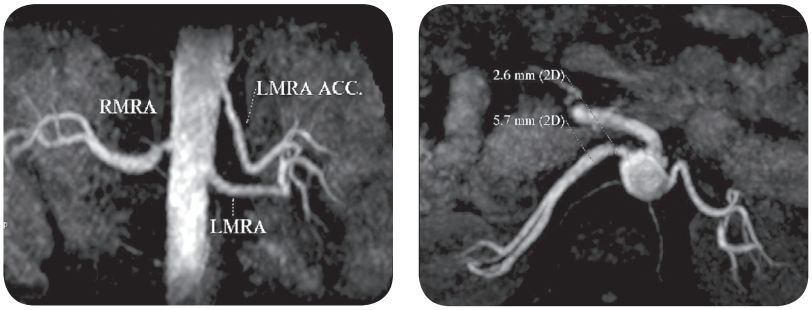

Figure 1. 52-year-old with hypertension and suspected renal artery stenosis.

Case 2

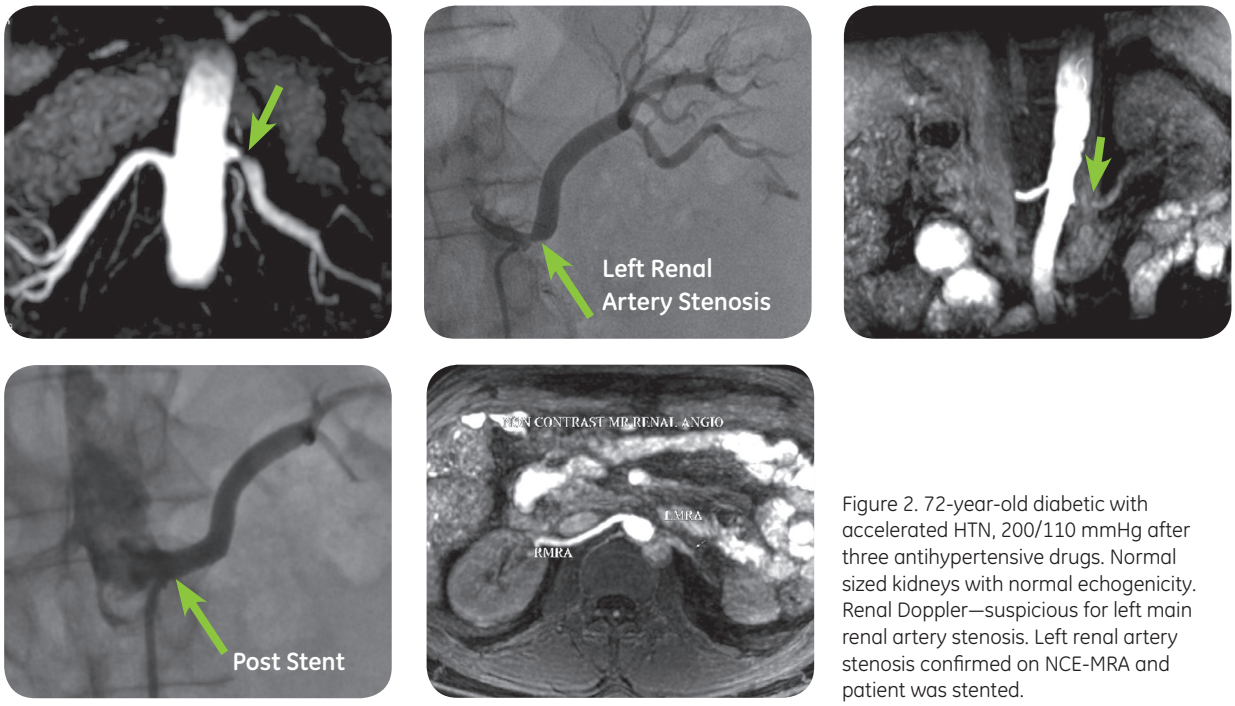

Figure 2. 72-year-old diabetic with accelerated HTN, 200/110 mmHg after three antihypertensive drugs. Normal sized kidneys with normal echogenicity. Renal Doppler—suspicious for left main renal artery stenosis. Left renal artery stenosis confirmed on NCE-MRA and patient was stented.

Case 3

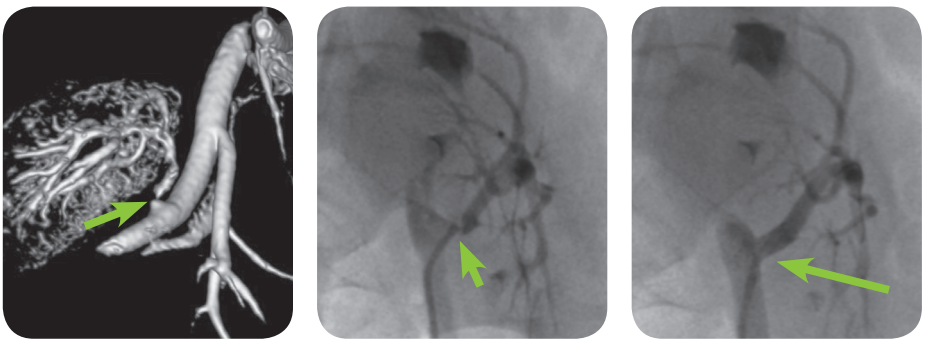

Figure 3. 32-year-old renal transplant recipient, three months post transplant. Presented with HTN and progressive raise of creatinine. Findings: MRA and cath angio of transplant demonstrate renal artery stenosis.

Case 1

Figure 4. 60-year-old diabetic with lower limb pain and suspected ischemia.

Case 2

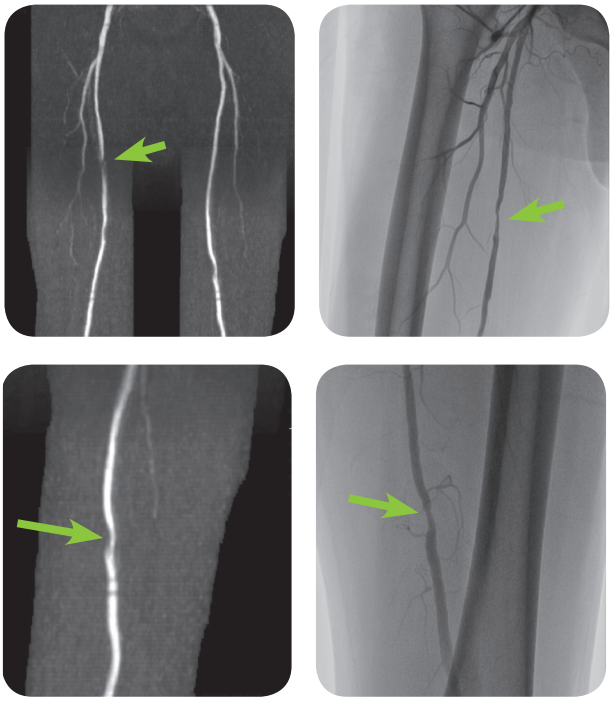

Figure 5. 48-year-old with left lower limb claudication (left common Iliac artery occlusion).
Findings: Right lower limb claudication, moderate stenosis in mid-right SFA and mild stenosis in mid-left SFA.

Discussion

NCE-MRA of renal arteries is emerging as a robust, accurate modality to evaluate renal arteries in patients with altered renal function. With MR, there is no patient exposure to ionizing radiation, as is the case with CT. Unlike CE MRA, where rare parenchymal enhancement/venous contamination can lead to an inaccurate result, NCE-MRA provides excellent contrast between vessels and adjacent soft tissues and has become the modality of choice in our facility for patients with renal dysfunction.

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1. Katzberg RW, Barrett BJ. Risk of iodinated contrast material-induced nephropathy with intravenous administration. Radiology. 2007;243:622-628.
2. Thomsen HS. Nephrogenic systemic fibrosis: A serious late adverse reaction to gadodiamide. EurRadiol. 2006;16:2619-2621.

Vijaya Bhaskar Nori, MBBS, MD, *(Radio-Diagnosis), is the Director & Chief Radiologist of Vista Imaging & Medical Centre, Hyderabad, AP, India. He completed his MBBS from Nagarjuna University in 1986 and received his medical degree in Radio-Diagnosis from the University of Health Sciences in 1992. Dr. Nori has delivered many lectures at national and international conferences and has co-authored publications in radiology journals. He specializes in MDCT and MR Angiography, with extensive pioneering work on non-contrast MR angiogram. He has done extensive work on MRCP, multi-modality liver imaging, and cardiac CT, and he is one of the MR pioneers in the state of AP.*

Vista Imaging & Medical Centre *offers the most advanced and comprehensive range of radiology services in the heart of Hyderabad, AP, India. With an infrastructure that is equipped to provide a truly unique alternative to traditional radiology imaging, Vista also offers the services of a highly skilled team of health care professionals, subspecialty radiologists, accredited technologists, and dedicated nursing staff.*

Optima* MR430s 1.5T

Magic Angle Effect in MR Imaging of Ankle Tendons

By Mario Padron, MD, Head of Radiology at Clinica CEMTRO, Madrid, Spain and Victoria Cavero, PhD, Global Product Manager SMR, GE Healthcare

Introduction

The influence of foot positioning on the prevalence of the magic angle effect (MAE) in ankle tendons was investigated. We compared MR imaging of the ankle of the same volunteer performed in a whole body MR 1.5T scanner with supine (neutral position of the foot) and prone (plantar-flexed foot) position in the Optima* MR430s. Magic angle effect is almost absent in the prone body position. In our clinical experience, we have learned that the MAE for the ankle tendon is almost absent in MR images of the ankle in the extremity system in prone position with plantar flexion of the foot.

MR technique

The ankle is imaged in the oblique axial plane (i.e., parallel to the long axis of the metatarsal bones). The patient is supine with the foot in about 20° of plantar flexion.

The magic angle effect is a manifestation of the anisotropic behavior of collagen on MR imaging. Under normal circumstances, the highly organized structure of collagen tends to restrict the mobility of local water protons and then promotes dipole-dipole interactions between them. Normally the dipolar interactions between restricted water protons in tendons cause very rapid T2 relaxation of about 250 µs. This rapid decay is responsible for the uniform low signal intensity exhibited by normal tendons on short TE MR sequences. The MAE describes the orientation dependence of T2 relaxation times.[1, 2] The MAE occurs in tissues with well-ordered collagen fibers, such as tendons, ligaments or hyaline cartilage.[3] Depending on the orientation of the fibers to the main magnet field, B0, an increase of the T2 relaxation time and respective signal, occurs. The maximum signal increase is observed at the magic angle of 55° relative to the orientation of B0[3] and is evident on short echo-time MR images with an echo time of less than 40 ms.[4] At 55° between the collagen fibers and magnetic field long axis, the minimization of dipolar forces causes an increase of T2 relaxation to ~22 ms.[1] Although this time is still short compared with other soft tissues, it can produce visible increased signal intensity on MR sequences using short TE. In comparison with sequences using long TEs the magic angle has negligible effect on tendon signal intensity, because the TE is much longer than the T2 relaxation time.

Mario Padron, MD
currently serves as the Head of the Radiology Department at Clinical CEMTRO in Madrid, Spain.

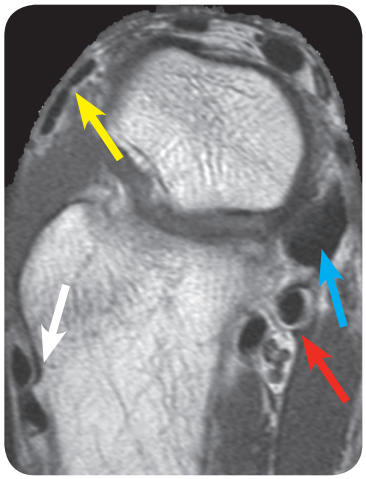

Figure 1. Foot Plantar-Flex 

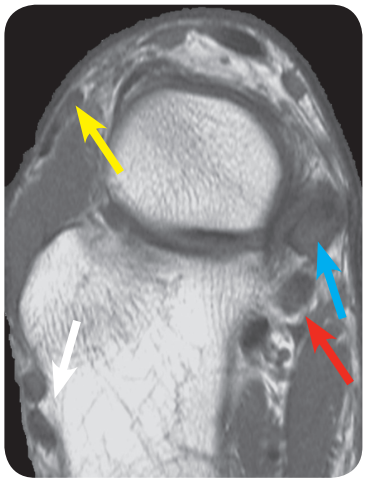

Figure 2. Foot Neutral Position 

Figure 3. Foot Plantar-Flex 

Figure 4. Foot Neutral Position 

Figures

Magic angle effect (MAE) in MRI in asymptomatic subjects. Traverse oblique T1-weighted images in supine body position with neutral position of the foot on whole body MR scanner (Figure 2, 4) and in prone body position with plantar flexion of the foot (Figure 1, 3) on the Optima MR430s.

- Figure 1, 2. Imaging plane just anterior to the sustentaculum tali at the level of the trochlear process of the calcaneus. With neutral position of the foot (2), MAE is visible in the PTT (blue arrow), FDL (white arrow), PB (red arrow) and EDL tendon (yellow arrow). With plantar flex of the foot in the Optima MR430s extremity dedicated system (1), all ankle tendons show a normal dark signal with no MAE.
- Figure 3, 4. Imaging plane at the inferior tip of medial malleolus. In Figure 4, with neutral position of the foot, the PB (red arrow) and the FHL tendon (white arrow) show diffusely increased signal due to MAE. In plantar flexion (3), a normal dark signal is seen for PB and FHL tendons.

PB: peroneus brevis tendon
FHL: flexor hallucis longus tendon
PTT: posterior tabialis tendon
EDL: extensor digitorum longus tendon
FDL: flexor digitorum longus tendon

Materials and methods

T1-weighted FSE images were obtained in the axial plane (TR 450/TE 14, 3-mm section thickness, 1 mm intervals, 16 cm field of view, matrix 384 × 352), on both Signa* HDxt and Optima MR430s extremity dedicated MR systems for the same volunteer.

Degeneration or tendinosis is characterized by increased signal intensity within the tendon on MR images and we need to take into account the MAE to reduce false positive diagnoses of tendon disease. In effect, MAE occurs in SE, FSE, and GRE sequences with varying effects. It is most severe in SE, moderate in FSE and weakest in GRE sequence. These critical TE values are 40, 70 and 30 ms for SE, FSE and GRE respectively. If increased signal from the magic angle effect is suspected on FSE sequences with short TE, only T2 weighted imaging would be helpful in eliminating magic angle effect.

Normal tendon anatomy

The ankle tendons are well visualized as low-signal-intensity structures with all MR imaging sequences.

In general, T1-weighted images provide good anatomic detail, whereas T2-weighted images are useful for assessing the abnormal increase in water that characterizes most pathologic conditions. Axial images are optimal for assessing morphologic features, longitudinal splits, tendon sheath fluid, and adjacent soft-tissue abnormalities. The posterior tibial tendon (PTT) is particularly susceptible to the magic angle effect at its insertion on the navicular bone.

Tendon injuries—tendinosis and tenosynovitis

The MR imaging characteristics of tendinosis include a fusiform shape and increased signal intensity within the tendon on T1-weighted and proton density–weighted images. Tenosynovitis is caused by inflammation or mechanical irritation of the tendon. MR images reveal fluid accumulation and synovial proliferation.

Discussion

The dipole interaction between two spinning nuclei, which leads to a reduced signal intensity, disappears at the "magic" angle of 55° to the main magnetic field B0 and the T2 decay is decelerated.[3] Tendons, ligaments and cartilage have a highly ordered structure with parallel orientation of collagen fibers (structural anisotropy). Water molecules binding to the collagen are ordered in-line with restricted mobility. If the collagen fibers are oriented 55° to B0, the spin interaction of the water molecules disappears and the T2 time is increased.

In most institutions, MRI of the ankle is performed in the supine body position, with the ankle in neutral position. But, in this position, increased signal occurs in all ankle tendons. This is in contrast to the prone body position with the ankle in plantar flexion in the extremity MR scanner where the MAE was rarely identified.

In case of normal signal on T2-weighted images, the MAE may be difficult to differentiate from signal increase of the tendon caused by early tendon degeneration seen on short TE images.[5, 6]

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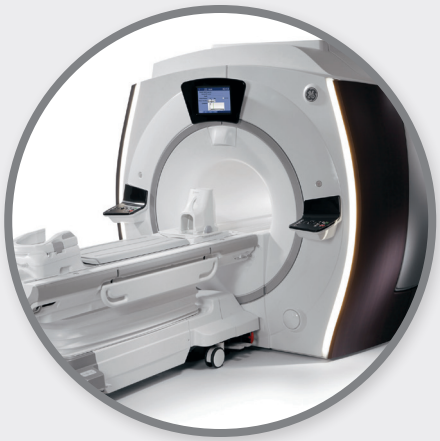
Mario Padron, MD, *currently serves as the head of the radiology department at Clinical CEMTRO in Madrid, Spain. After obtaining his MD degree from Universidad Complutense de Madrid, Dr. Padron completed his residency in internal medicine and radiology at Fundacion Jimenez Diaz Universidad Autonoma de 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 a Spanish Olympic Committee expert diploma. Dr. Padron frequently conducts lectures and is the chairman of the European Society of Musculoskeletal Radiology for 2013.*

Clinica 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 electronic medical records enables clinicians to know the status of all patients in real time.*

MR Abdominal and Bilateral Lower Arteries Angiography

By Ravin Sharma, MD, Radiologist,
Ganesh Diagnostic & Imaging Centre Pvt. Ltd., India



Discovery* MR750w 3.0T

Introduction

The patient has chronic kidney disease and cannot be given MR or CT contrast.

MR technique

Sequences were obtained using the wide bore Discovery* MR750w 3.0T. Non-contrast MR angiography of abdominal aorta and bilateral lower limb arteries with MIP and source images is done using non-contrast angiography techniques.

Patient history

The 53-year-old patient is a follow-up case of right aorto femoral graft and left femoro popliteal graft.

MR Parameters	
MR Technique-Non-Contrast (Inhance) Peripheral Angio	
No of Stations:	3 Stations
Gating Triggering:	PG
Patient Entry:	Feet-First
Patient Position:	Supine
Coil Configuration:	Body
Pulse Sequence:	2D Inhance IFIR
Imaging Options:	FC, Gat, Seq, Fast, ZIP 512
Flip Angle:	65
TR:	Minimum
TE:	Minimum
Receiver Bandwidth:	125.00
Freq:	320
Phase:	224
Freq DIR:	R/L
Phase FOV:	0.50
Minimum Trigger Delay:	1
Views per Segment:	32
View Order:	Bottom/Up
SAT Location:	Inferior

Ravin Sharma, MD
is a radiologist at Ganesh Diagnostic & Imaging Centre Pvt. Ltd. in New Dehli, India.

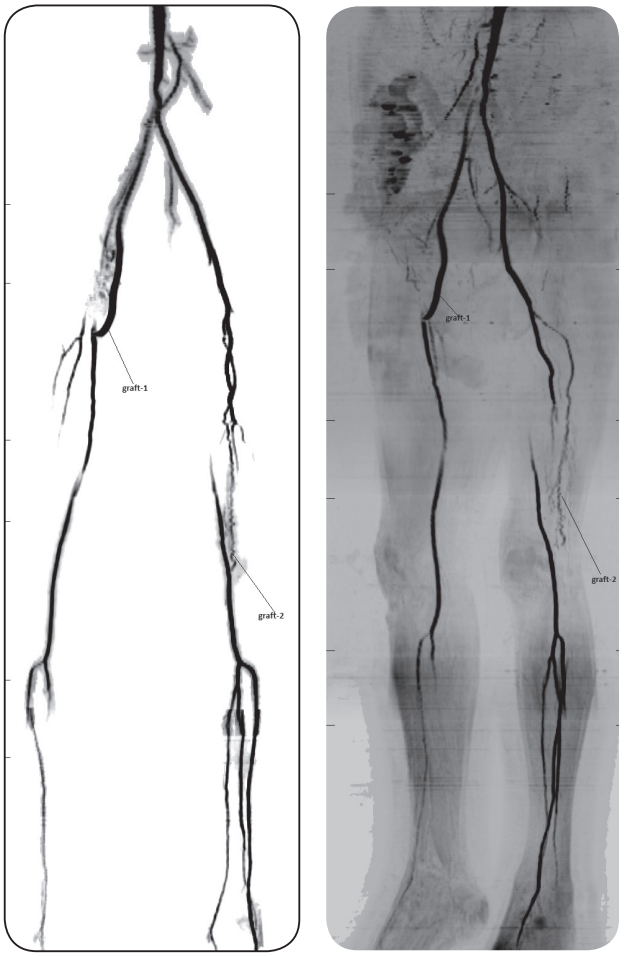


Figure 1. Lower limb arteries showing absent flow related enhancement of left distal SFA with distal reformation by collaterals. Left femoro-popliteal bypass graft is not visualized suggesting occlusion.

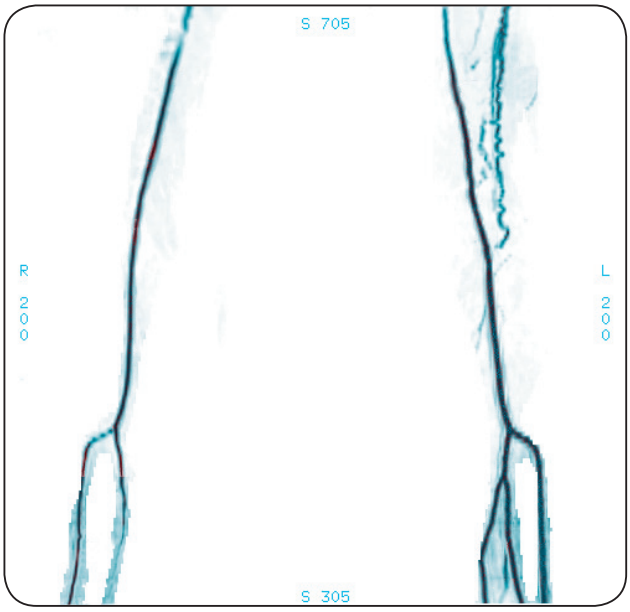


Figure 2. Distal B/L SFA and popliteal arteries are normal.

Figure 3. Shows left accessory renal artery.

MR findings

The study shows normal course and caliber of the abdominal aorta with no obvious stenosis. Celiac artery and superior mesenteric arteries are normal and show gradient hyperintense signals. Both renal arteries are normal in origin and caliber with no stenosis or narrowing. The renal arteries are dividing close to the hilum. Two left accessory renal arteries are seen arising from the abdominal aorta, one at the level of the main left renal artery and the other arising approximately 36 mm below the left main renal artery.

Right common iliac, external, and internal iliac arteries are mildly attenuated, however, no obvious luminal blockage is seen. Long segment (approximately 98 mm in length) narrowing of mid right SFA with loss of gradient hyperintense signals. Patent aorto-femoral graft with

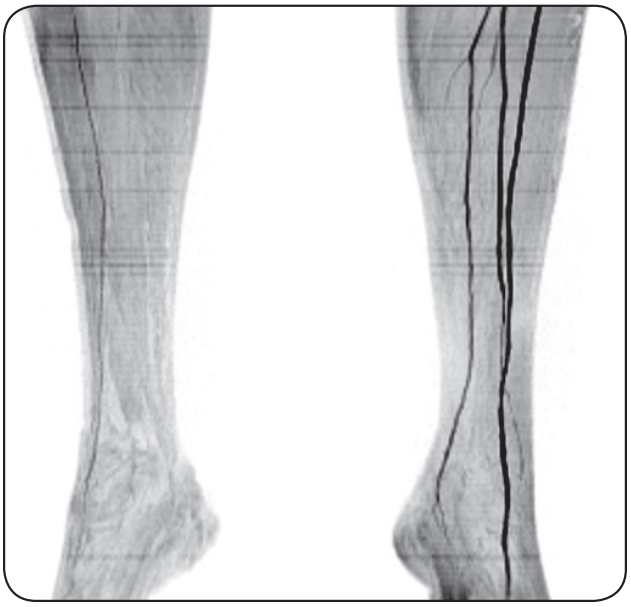


Figure 4. Right leg shows marked attenuation of right ATA and common peroneal and posterior tibial arteries. Left anterior post-tibial arteries and tibio-peroneal trunk are normal.

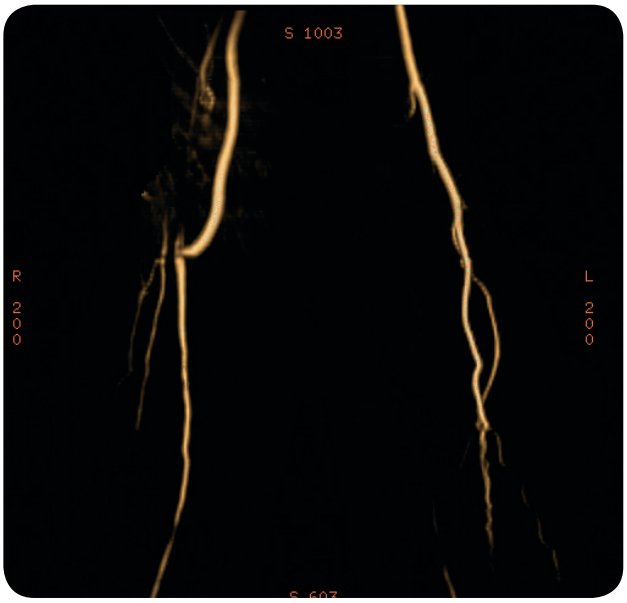


Figure 5. Long segment occlusion of right mid SFA with patent aortofemoral graft.

gradient hyperintense signals in distal SFA. Right popliteal and right tibio peroneal trunk appear mildly attenuated, however, show normal gradient hyperintense signals. Right interior tibial, common peroneal, and posterior tibial arteries are markedly attenuated.

Left common iliac, external, and internal iliac arteries are normal. Left common femoral and proximal superficial femoral arteries show mild attenuation, however, gradient hyperintense signals are maintained. No evidence of luminal occlusion is seen. Distal left SFA shows marked luminal narrowing with loss of gradient hyperintense signals and surrounding collateral channels. Left femoro-popliteal graft is not visualized. Left popliteal, tibio-peroneal trunk, anterior and posterior tibial arteries are normal.

Discussion

By utilizing the non-contrast Inhance sequence to visualize the peripheral and lower limb arteries, we were able to see the patency of the bypass graft and assess flow.

Ravin Sharma, MD, *is a radiologist at Ganesh Diagnostic & Imaging Centre Pvt. Ltd. in New Dehli, India. He previously worked at Safdarjung Hospital in Delhi and he received his medical degree from Rajiv Gandhi University of Health Sciences in Bangalore. Dr. Sharma presented a paper on MRI and CT regarding the evaluation of Posterior Fossa Brain Tumor. He has over 15 years of radiology experience, including MR exams on GE Healthcare's Optima* MR450w 1.5T and Discovery MR750w 3.0T.*

Ganesh Diagnostic & Imaging Centre (GDIC) Pvt. Ltd. *was established in 2001 by Dr. Ravin Sharma in the name of his father, Ganesh Chand Sharma. The Centre has a team of 35 specialized doctors including radiologists, pathologists, cardiologists, nuclear medicine specialists, and anesthetics, technicians, nurses, and 40 MBAs. GDIC is affiliated with NABL Accredited Labs, assuring quality results.*

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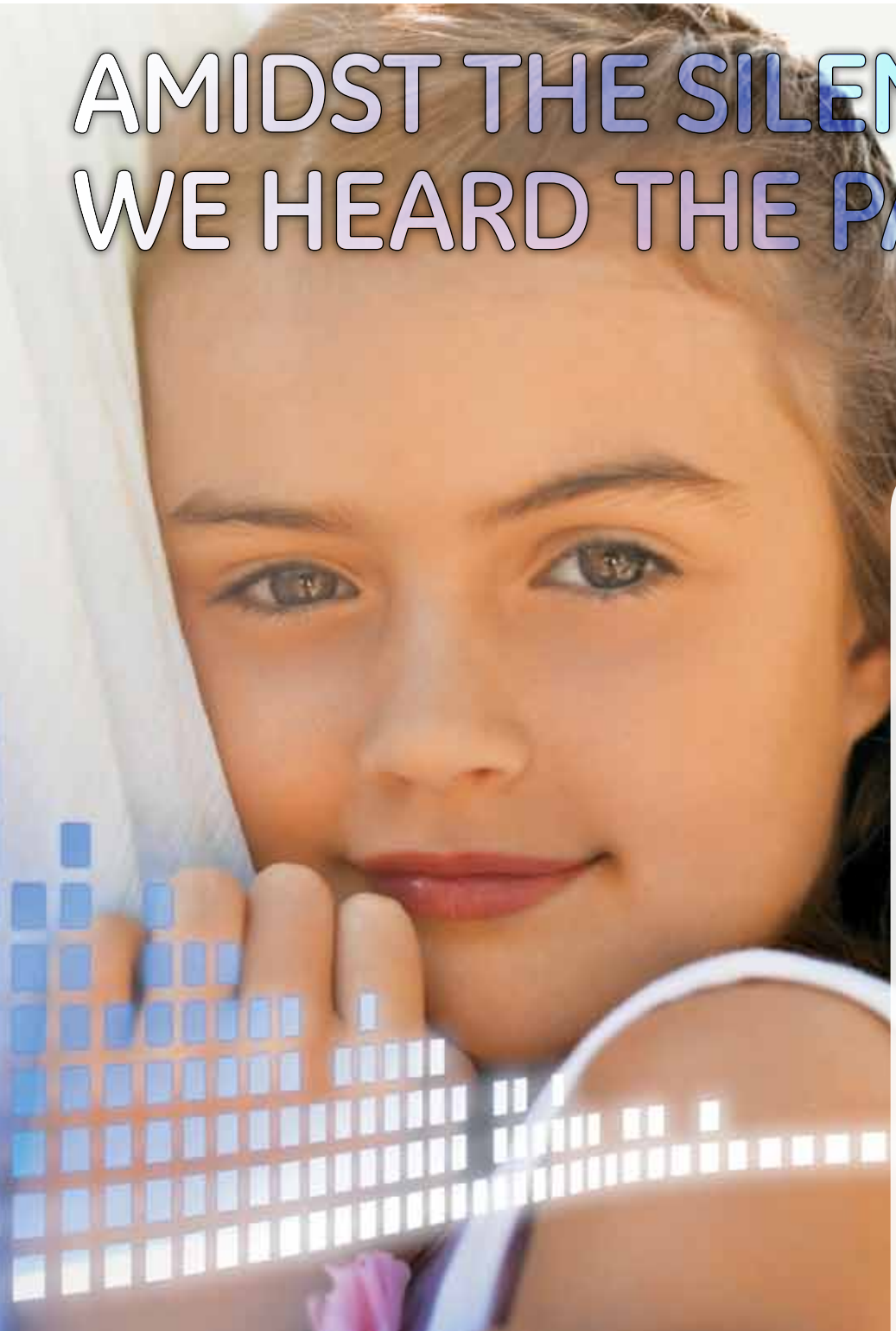
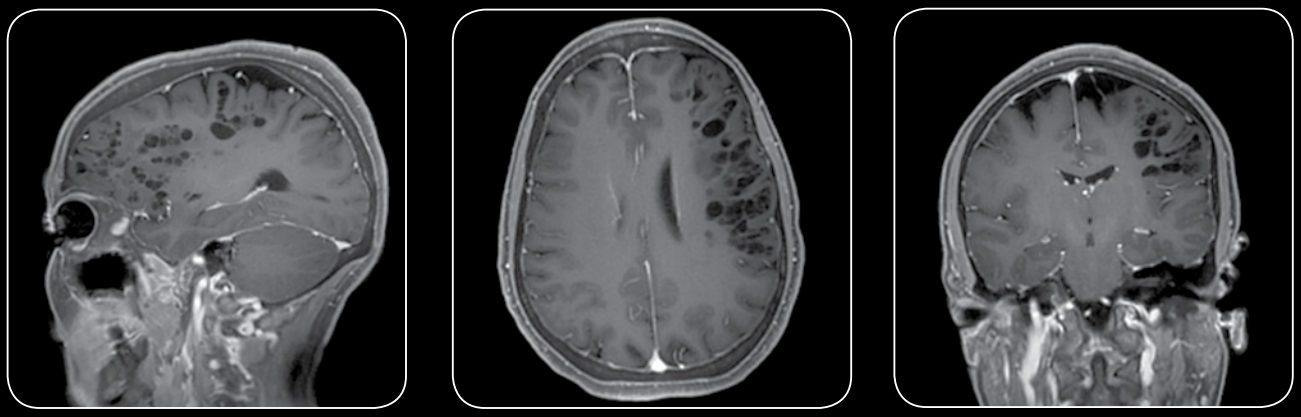


Can you imagine a mom reading a story to her son during his MR scan? Soon, this scenario could become a reality. While an abundance of healthcare providers have dedicated themselves to greater compassion in medicine, many radiology practitioners have focused on image quality rather than the human element. Several years ago, GE Healthcare initiated a quest to change that. Like Robert Frost's famous poem which reads, 'Two roads diverged in a wood, and I—I took the one less traveled by, and that has made all the difference,' the company is taking the less-traveled road of Humanizing MR while continuing its tradition of uncompromised image quality.

To truly Humanize MR, Jacques Coumans, PhD and CMO of Global MR at GE Healthcare, explains that patient-centricity must touch everyone in the scanning process and help make their lives better. For example, the patient receives a more comfortable scanning experience; the technologist experiences ease-of-use, speed, and simplicity; the radiologist can count on superb image quality, as well as advanced procedures, exams, and protocols; and the administrator realizes economic sustainability.

‡ Not CE marked. Cannot be placed on the market or put into service until it has been made to comply with the Medical Device Directive requirements for CE marking.



Post contrast T1w Silent Scan Sagittal acquisition with Axial and Coronal reformats demonstrating dilated Virchow-Robin spaces.

"This caring focus has not taken away our ultimate goal of bringing the best possible diagnostic imaging quality to radiologists," says Coumans. "At the same time, we are building GE Healthcare into the coolest MR brand on the planet by making patients the measure of our technological choices."

Silently humanizing MR

To further the Humanizing MR commitment, GE Healthcare has introduced many new technologies including the wide bore w Series—the Discovery* MR750w 3.0T and the Optima* MR450w 1.5T, both with the Geometry Embracing Method (GEM) Suite of coils. "Patients of all ages deserve solutions adapted to their differing bodily habitus and disease symptoms," comments Coumans.

Using the symbol of Caring Hands as inspiration, the systems are soothing and welcoming for patients; for example, the soft LED accent lights designed to create a rich and warm environment to emphasize patient care. Plus, the lighter, more flexible GEM Suite of coils embrace patients, transforming the environment from cold and clinical to warm and inviting.

In collaboration with PDC Facilities, Inc. (Hartland, Wisc), GE Healthcare launched the comforting and personalized Caring MR Suite. Using the w Series as its foundation, the suite provides lighting, scenery, and music that can be customized by patients using a digital tablet. It helps patients—in particular, children and adults with claustrophobia—feel more relaxed and in control during their MR scans. For technologists, this equates to higher-quality imaging and shorter exam times.

While these are some of GE Healthcare's many strides in humanizing MR... there's still a lot left to do. In particular, the company has been busy listening to patients who complain about loud, anxiety-elevating scanner noise generated during MR exams. As a result of this input, GE Healthcare introduces Silent Scan‡, revolutionary technology designed to address one of the most significant impediments to patient comfort—excessive acoustic noise generated during an MR scan.

Conventional MR scanners can generate noise in excess of 110 dBA (decibels) levels, roughly equivalent to rock concerts. GE's exclusive Silent Scan technology is designed to reduce MR scanner noise to near ambient (background) sound levels, and, thus can improve a patient's MR exam experience. The popular GE booth at RSNA showcased the Caring MR Suite featuring the Discovery MR750w 3.0T, as well as a demonstration of Silent Scan on the Optima MR450w 1.5T: with a real-time video link to a bay in Waukesha, Wisc. where technologists scanned live to demonstrate the acoustic reduction and image quality. More than 4,000 visitors experienced, and were buzzing about, the Silent Scan difference.

Additionally, this year's Arab Health—the Middle East's premier healthcare exhibition and conference—opened with Silent Scan and the real-time video link, and GE Healthcare's popular booth at the 2013 European Congress of Radiology featured the revolutionary technology.

DIGITAL DIVE
Don't hear it to believe it (Silent Scan noise comparison video) at tiny.cc/sps131

"What I like about GE's approach is that it's a new way to look at MR—breaking down the barriers of pre-conceived notions that noise is part of MR."

Dr. Mark DeLano

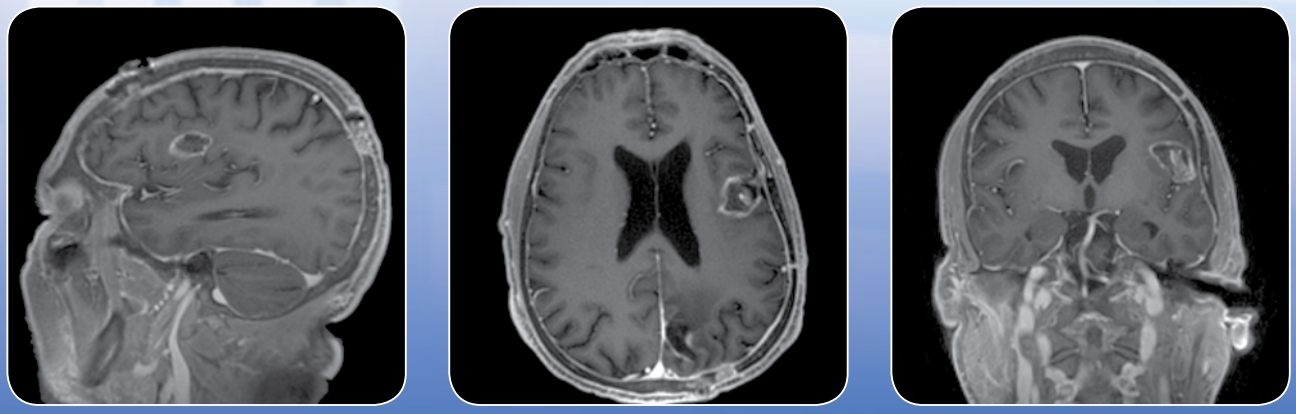
The buzzing, clicking, drumming

"Many people describe the MR scan noise as buzzing, clicking, or drumming. You do everything possible to provide your patients with a comfortable experience, but realistically, MR exams are loud," says Bryan Mock, MR Product Manager with GE Healthcare. "The scanner noise can elevate anxiety, especially with geriatric and pediatric patients; damage hearing, if the levels are high enough and the subject does not use hearing protection; and cause a startle response, inducing motion artifacts. An uncomfortable, moving patient can lead to poor image quality and time-consuming re-scans."

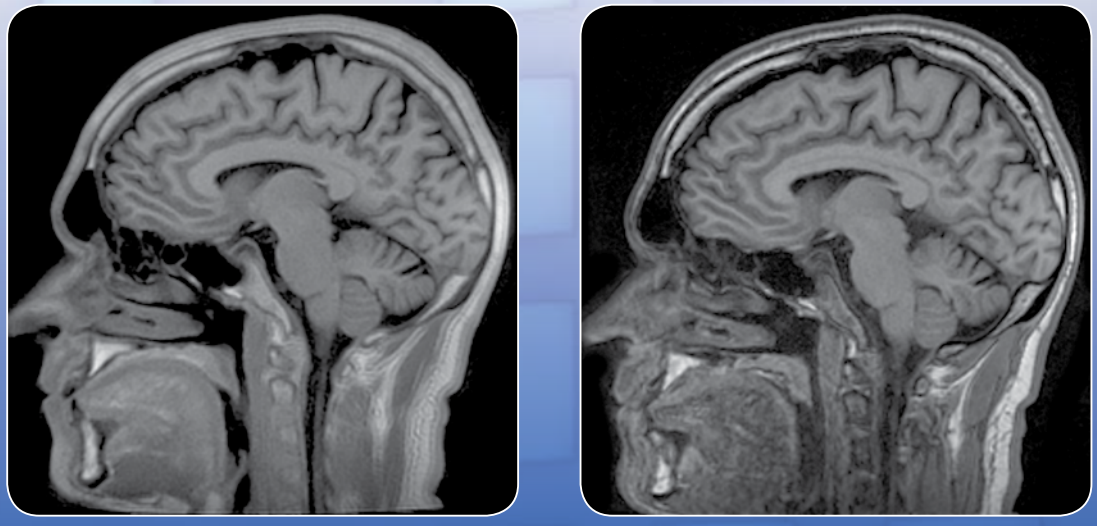
What makes the noise? Picture or "think of" a speaker—inside, there's a big magnet with a wire around it. An impulse of electric current through the wire in the presence of a magnetic field creates vibration resulting in the generation of noise. It's the same with an MR system. The MR imaging gradients are the primary source of noise within the MR suite. Specifically, conventional MR imaging requires that the gradients are rapidly switched on and off to encode the MR spins to produce images with the desired contrast. The imaging gradients are produced by forcing electric current through the gradient coil as it sits inside the main magnet. Current flowing through the wire in a magnetic field creates a Lorentz force that induces motion within the gradient coil.

Since the gradient coil is fixed within the system, these forces cause mechanical vibrations that generate noise within the exam room and surrounding structures. Each imaging sequence generates a unique noise profile since the gradients employed change depending on the desired image contrast (e.g, Diffusion Weighted EPI "sounds different" compared to Fast-Spin Echo sequences).

Mark DeLano, MD, Advanced Radiology in Grand Rapids, Mich. and Director of the Division of Radiology at Michigan State University, has Silent Scan installed on a GE Healthcare wide bore scanner as part of the GE-sponsored research protocol. At his facility, the biggest impediments to patients' acceptance of MRI are claustrophobia and the noise. "So often we hear people complaining that it's like a jackhammer, but it's more than just an annoyance—there's a negative health impact on people from noise beyond potential hearing impairment, such as cardio-vascular disease and sleep disturbances," he comments. "So having healthcare as a source of noise doesn't make much sense. This is important to our MR workers, as well as patients. The impact on both is something we shouldn't ignore, especially when we can achieve high-quality images without the noise."



Post contrast T1w Silent Scan Sagittal acquisition with Axial and Coronal reformats demonstrating enhancing lesion in the left frontal lobe.



Comparison of Sagittal Silent Scan (left) and BRAVO (right) demonstrating similarities in the grey-white contrast.

Reducing acoustic levels

With the advent of stronger and faster gradients over the last two decades, acoustic noise levels have increased and have required new engineering solutions to achieve acceptable levels. Some MR sequences exceed 110 dB(A), which can induce hearing damage if experienced for more than 30 minutes, according to the Occupational Safety & Health Administration.[1] MR examinations dictate the use of hearing protection, such as foam earplugs, to reduce the noise to safe levels—below 99 dB(A)—for patients.

Historically, reducing the noise generated by an MR scanner has been achieved by adding insulation to the MR system to minimize vibration and muffle acoustic noise; modifying internal structural supports to change the natural mechanical frequency of the MR system; or reducing the gradient slew-rate (or how quickly the gradients are allowed to change) to reduce the induced mechanical force/vibration—the latter, however, results in longer scan times.

"We wouldn't intentionally put ourselves into a situation where we are going to be constantly bombarded with noise, right? Yet until now, we all accepted noise as a necessary part of MR. What I like about GE's approach is that it's a new way to look at MR—breaking down the barriers of pre-conceived notions that noise is part of MR," notes Dr. DeLano.

Novel approach

GE Healthcare has taken a novel approach to minimizing acoustic noise levels by attacking the problem at the source of the noise... the rapidly switching gradients—dramatically reducing the acoustic noise of the MR exam. "Silent Scan eliminates the noise by modifying how the MR data is acquired rather than simply derating the traditional imaging sequence or muffling the sound already produced. It's truly an industry-changing advancement toward humanizing MR," says Mock.

The secret behind Silent Scan technology is in the novel combination of a new 3D acquisition and reconstruction technology, highly stable system power electronics (gradients and RF) and fast RF switching within the RF coil architecture. These new acquisitions slowly step the gradients while maximizing the amount of time for data collection during a 3D acquisition. The data acquired is isotropic and different contrasts can be achieved with novel preparation sequences. The technology requires extremely stable gradients and fast switching RF coils to avert image artifacts and maximize signal-to-noise ratio. It has shown promise at generating the necessary clinical contrast while reducing the scanner noise to near ambient (< 3dB(A) above ambient) levels.

Dr. DeLano and his team have investigated the use of Silent Scan on pre-operative and post-operative patients for brain tumors and epilepsy, and for providing a 3D volumetric, T1-weighted image that is excellent for looking at the hippocampi. Also, when they're doing epilepsy workups, the technology has compared favorably to other 3D, T1-weighted images for volumetric imaging.

Enjoying the silence

"The new Silent Scan sequences produce image quality that's every bit as good as the traditional techniques, but in a way that is much more comfortable for patients. We scan many elderly, as well as pediatric patients—two populations vulnerable to hearing damage from noise. Some of the Silent Scan techniques are virtually imperceptable from quiet. As a matter of fact, in our bay, the ambient noise level runs about 70 dB(A), and the sound level when the scanner is on is 70.3 dB(A). There's only a minor difference from ambient noise," says Dr. DeLano.

He continues, "Patients who are sensitive to hearing loss or those with anxiety are going to do better when the scan experience is more comfortable. It's so much quieter, that you almost have to explain to patients that the scanner is still running—in the scanner, patients sometimes get anxious when the machine seems idle, and when there's no noise, they are prone to feeling forgotten. We need to remind them that we are still there."

Dr. DeLano says that uniformly, his patients love Silent Scan. But he notes that silent scanning is also critical for techs. At the Spectrum Health Blodgett Campus, they have two MR scanners that work at the same time. When both are running, a number of intrusions can make the environment extra loud, and impact communication with the patient for breath-holding exams and coordination between multiple care team members, such as nurses and anesthesiologists. "Our techs have been uniformly supportive and delighted with the absence of the noise. It's almost a little bit startling until I went into the scan room, I did not fully appreciate the substantial difference it makes. You don't hear any noise generated by the system."

He continues, "When working daily in the MR environment, you're used to hearing the noise and you use it as an auditory cue as to what's going on with the scanner. The absence of noise prompts the technologists to pay attention to scanning in a different way because there isn't the auditory cue that the scan is still running. It's changing the experience of the technologists in a positive way and it allows them to focus more appropriately on the other aspects of the examination."

Dr. DeLano says the MR technologists are impressed with how much quieter the console is and see how comfortable the patients are. "The MR experience is very stressful, as it can be blisteringly loud. This can make the experience challenging for the tech, as well as the patient. The combination of the GE wide bore scanner and the virtual silence makes the entire experience much more soothing. There's really no question about it."

"The new Silent Scan sequences produce image quality that's every bit as good as the traditional techniques, but in a way that is much more comfortable for patients. We scan many of elderly as well as pediatric patients—two populations vulnerable to hearing damage from noise. Some of the Silent Scan techniques are virtually imperceptable from quiet."

Dr. Mark DeLano

DIGITAL DIVE
Silent Scan Deluxe visit tiny.cc/sps138

> "The importance of communication in the OR is critical. You want the surgeon concentrating on the complex procedures and the anesthesiologist focusing on your patient, rather than hoping they can tune out the noise."
>
> *Dr. Mark DeLano*

The future is silent

Regarding the advancements of Silent Scan, Dr. DeLano feels that we've only begun to scratch the surface. For example, MR angiography (MRA) is something that he'd like to exploit because the blood vessels are inherently very bright on this type of a scan. "It would be wonderful if we could make everything silent. The ability to add other exams such as MR angiography is also of great interest. We receive brain MRA referrals daily, often for patients with headache. It would be a much more positive scan experience without any noise." Dr. DeLano continues, "GE has redefined the MR experience. As creative innovations are introduced we become open to possibilities previously considered impossible."

Another example of where the MR noise gets in the way, according to DeLano, is in MR units in the operating room. "The potential for having Silent Scan in the OR could make a huge difference," offers Dr. DeLano. "The importance of communication in the OR is critical. You want the surgeon concentrating on the complex procedures and the anesthesiologist focusing on your patient, rather than hoping they can tune out the noise."

He continues, "And don't underestimate the importance of the silent scan for the neighboring operating rooms. Sound penetrates all the walls… and while we do our best to dampen the noise, it is distracting for clinicians in the other OR suites."

According to Dr. DeLano, Silent Scan is a revolutionary approach to the way that MR scanning is done—representing a major leap in terms of technology. "For the future, it means there's going to be a stronger focus on patient comfort with respect to sound levels on all exams. I envision this will only be the beginning of a suite of applications, from neuro through body imaging, with substantially lower sound pressure levels and a much higher level of patient comfort."

Reference
1. www.osha.gov

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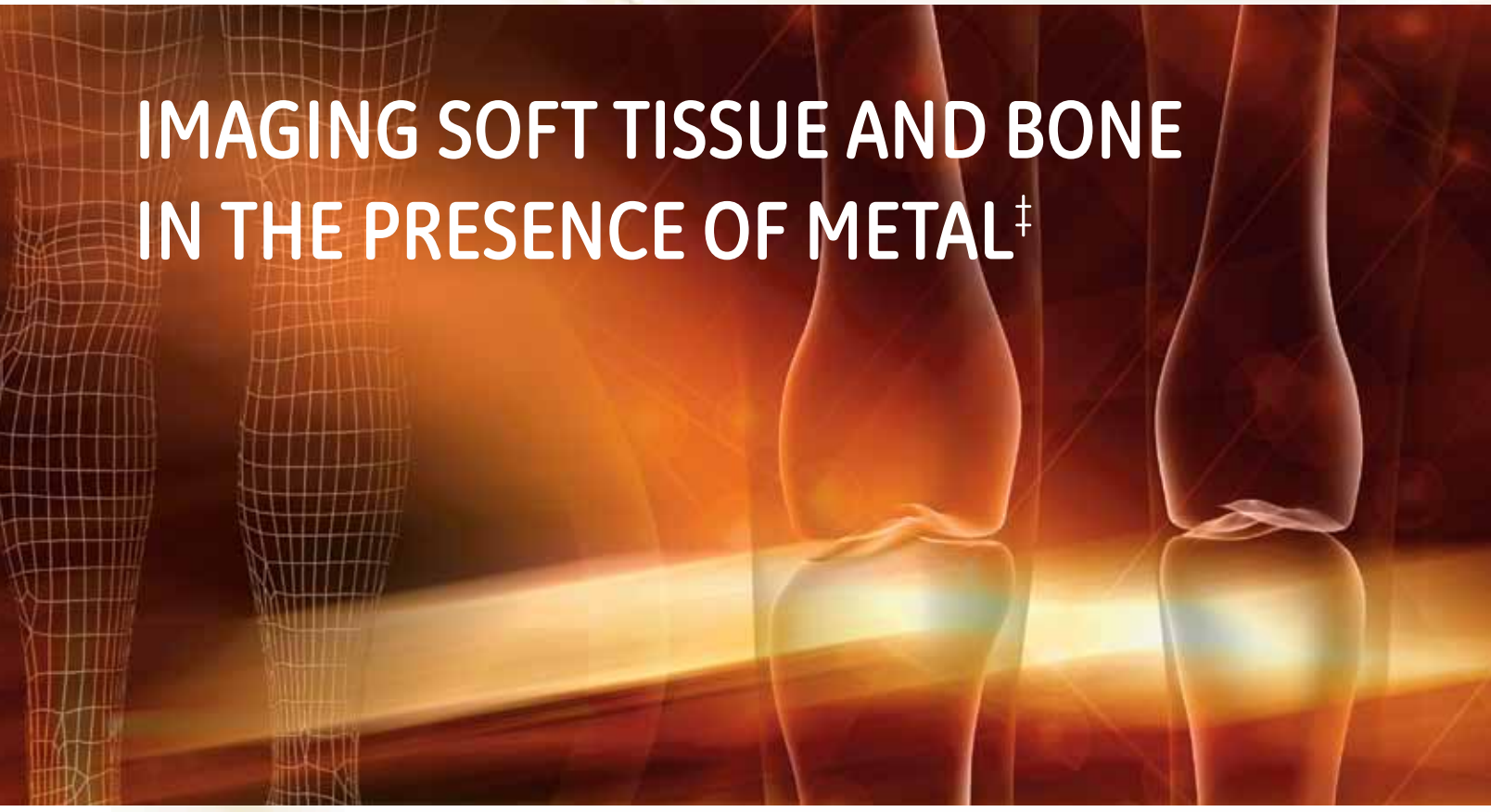
Advanced Radiology Services, PC *is a team of over 100 Michigan-based radiologists, providing state-of-the-art diagnostic and interventional radiology services and partnering with physicians and healthcare systems across Michigan. Spectrum Health, comprised of nine hospitals and 183 services sites, is a not-for-profit health system in West Michigan offering a full continuum of care. Michigan State University is the nation's pioneer land-grant university and home to nationally ranked and recognized academic and research programs.*



IMAGING SOFT TISSUE AND BONE IN THE PRESENCE OF METAL‡

Remarkable gains in life expectancy coupled with the desire to remain active in a person's later years have led to a growth in orthopedic implant surgeries. Osteoarthritis is a key contributing factor for joint replacement, and the number of people suffering from this disabling disease is expected to climb. Contributing to the prevalence of osteoarthritis is the growing incidence of obesity, the main risk factor for osteoarthritis other than age and sex.[1]

Between 2000-2009, the number of hip replacement surgeries has increased by more than 25%, while the number of knee replacement surgeries has nearly doubled in most OECD countries.[1] Unfortunately, there are thousands of recalled implants each year,[2] and many of these recalls lead to revision surgeries. U.S. data for revision surgeries predicts near exponential growth; 137% for hip and 601% for knee between 2005-2030.[3]

Patients with complications from total joint replacement (TJR) surgeries typically present with pain and/or altered gait mechanics. Metal‡ or plastic wear at a rate of about 0.1 mm/year[4] and particles often end up in the tissue, leading initially to inflammation (e.g., synovitis) and progressing to bone resorption (e.g., osteolysis), which can lead to implant loosening, dislocation, and misalignment. Furthermore, the physical integrity of implants can also necessitate intervention. Regardless of the cause for orthopedic implant failures, medical imaging of the joint and implant is required to evaluate the integrity of the surrounding soft tissue envelope and osseous structures prior to revision procedures.

Hollis G. Potter, MD
is Chief, Division of Magnetic Resonance Imaging and Director of the MRI Laboratory at the Hospital of Special Surgery (HSS) in New York.

Indications for Use

‡MAVRIC SL is a combination of an acquisition technique and post-processing software intended for use on GE 1.5T and 3.0T MR systems. MAVRIC SL is suitable for use on all patients with passive MR Conditional orthopedic implants that are scanned according to the conditions of safe use for the specific MR Conditional implant being scanned. In addition, MAVRIC SL is suitable for use on patients without implants that are cleared for MR exams.

MAVRIC SL helps reduce artifacts caused by presence of metal in both in-plane and through-plane dimensions compared to conventional MR imaging techniques. Thus MAVRIC SL allows visualizing more tissue in the vicinity of MR Conditional implanted metal instrumentation.

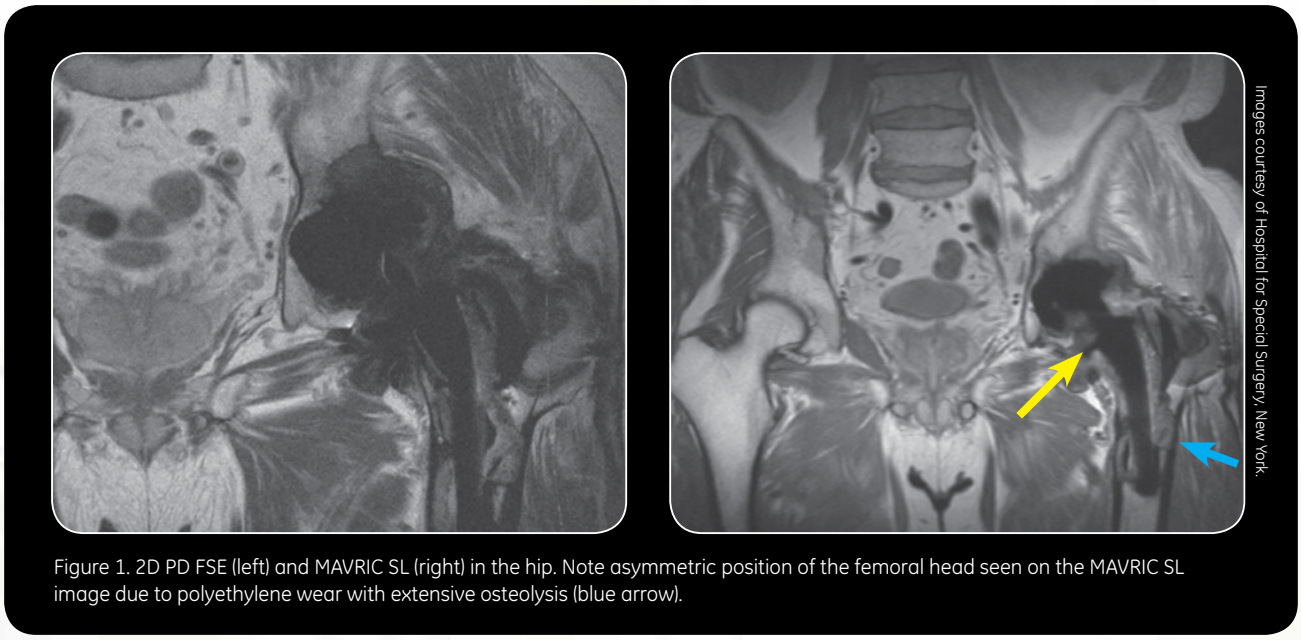
When interpreted by a trained physician, images generated by MAVRIC SL provide information that can be useful in determining a diagnosis.

Medical imaging has transformed surgical implant procedures by providing the surgeon with information on anatomy before the patient enters the surgical suite. Yet, for many TJR patients, imaging studies were substantially compromised due to the presence of metal-induced‡ artifacts that often obscure adjacent tissue.

According to Hollis Potter, MD, Chief, Division of Magnetic Resonance Imaging and Director of the MRI Laboratory at the Hospital of Special Surgery (HSS) in New York, while several imaging modalities may be typically considered to evaluate patients with metalic‡ implants, most imaging centers start with conventional radiographs due to their lower cost and ability to depict implant alignment and periprosthetic fractures.

"There is a lot of information we can obtain from an X-ray," Dr. Potter explains. "However, it is well documented (in the literature) that radiographs have poor reproducibility and are inaccurate regarding bone loss around implants. Additionally, imaging around complex joints, such as the shoulder and hips, may require 3D imaging and modeling for the surgeon to gain insight into what is occurring with the bone," Dr. Potter adds.

While CT has been utilized for imaging TJR, it has far less soft tissue contrast compared to MR and ultrasound, and image quality is also impacted by beam-hardening artifacts. Clinicians and technologists can overcome the beam-hardening artifact by increasing the effective patient radiation dose; however, concerns regarding a



Images courtesy of Hospital for Special Surgery, New York.

Figure 1. 2D PD FSE (left) and MAVRIC SL (right) in the hip. Note asymmetric position of the femoral head seen on the MAVRIC SL image due to polyethylene wear with extensive osteolysis (blue arrow).

These images were generated using MAVRIC SL software and are representative of the quality that users should expect. However, GE Healthcare is not always able to confirm if they are of MR Conditional implants or if scanning was in accordance with the implant's instructions for use. MAVRIC SL should only be used with MR Conditional implants and within the MR conditions specified for those implants.

patient's cumulative ionizing radiation dose make this a less preferred imaging option.

Imaging soft tissue and bone loss around metallic‡ implants provides important information for the surgeon. Published studies demonstrate that MRI can more accurately detect bone loss when compared to plain-film X-ray.[5-9] "While this result is intuitive, the authors also saw abnormal or synovial responses in every patient that had bone loss," says Dr. Potter. "MRI is the best means in which to assess soft tissue response; however, we had to get around the metal‡ artifact."

Overcoming metal‡ artifacts in MR imaging

Dr. Potter began researching the utility of MR to image soft tissue around joints in the mid-1990s. She eventually turned her attention to the use of MR to assess complications from total joint replacements. In 2004, she published a paper demonstrating the benefit of MR in assessing osteolysis and particle disease in the vicinity of total hip replacements.[5] To reduce the artifacts in MR images, which are predominantly caused by the high magnetic susceptibility of implanted metallic‡ alloys, Dr. Potter optimized conventional fast-spin echo imaging techniques to use thin slices, and high readout (or frequency encoding) bandwidths. Despite these efforts, substantial susceptibility artifacts remained. It was clear that a more aggressive approach to susceptibility artifact reduction would be required to improve clinical MR capabilities to assess complications of arthroplasties.

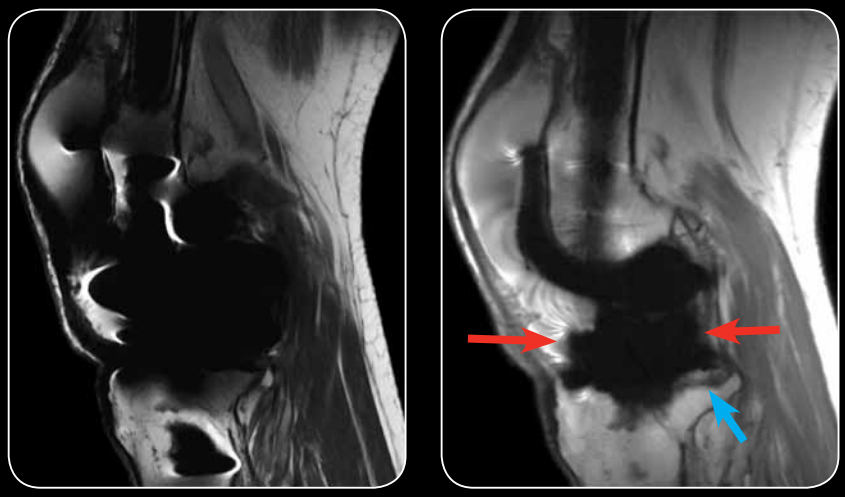
Without an in-house physicist, but determined to find a solution, Dr. Potter approached the MR industry, challenging the manufacturers to meet a growing clinical need. "GE was the only company willing to rise up to the challenge… this is really a perfect model of an industry and academic partnership," she explains. Dr. Potter collaborated with Kevin Koch, an MR physicist at GE Healthcare, and together they forged ahead. "We had a market, but we couldn't move forward without expertise from GE Healthcare's Applied Science Laboratory," she adds. "GE's ASL assigned a physicist to the problem, and Kevin met with patients, orthopedic surgeons, and cell biologists to more fully understand the breadth of the problem." Together, Dr. Potter, HSS, and GE Healthcare then developed the initial MAVRIC sequence.[10]

GE Healthcare also collaborated with Brian Hargreaves, PhD, and Garry Gold, MD, at Stanford University, who developed an alternative approach to metal‡ artifact reduction.[11] This collaboration led to the important addition of spatial volume selectivity to the MAVRIC method. In conjunction with a post-processing deblurring algorithm, this modification of the basic MAVRIC approach led to the final implementation of the MAVRIC SeLective (SL) method.[12] The majority of Dr. Potter's clinical experience has been with the MAVRIC SL prototype sequence.

MAVRIC SL is a new advanced magnetic resonance imaging technique for imaging bone and soft tissue near MR Conditional metallic‡ devices. Paramagnetic metallic‡ alloys utilized in MR Conditional implants generate severe disturbances of the static magnetic field utilized for spatial encoding of MR images. These magnetic field disturbances result in signal voids, ectopic hyperintensities, and geometric distortions of the tissue adjacent to metallic‡ interfaces, thereby obscuring clinically relevant anatomy. MAVRIC SL is designed to greatly reduce these artifacts when compared to conventional fast-spin echo techniques.

The MAVRIC SL method deploys a 3D fast-spin echo technique to acquire multiple overlapping volumes acquired at discrete frequency offsets. These individual volumes, which are free of through-plane distortions and limit the maximum amount of in-plane distortion, are then combined to form the final MAVRIC SL image. Slab-selectivity is enabled through a novel multi-spectral 3D view-angle-tilting method to further improve image integrity and eliminate through-plane aliasing. Finally, a deblurring post-processing technique is implemented to optimize the volume combination process.

Think of the process as similar to taking a photograph using individual "shots" that detect different colors. One shot captures all of the blue components of the image, while another shot captures all of the red components and so on. When all of the shots are added together, the final image provides a combination of all of the colors and gives you a complete representation of the photographed scene.



Images courtesy of Hospital for Special Surgery, New York.

Figure 2. 2D PD FSE (left) and MAVRIC SL (right) in the knee. Note visualization of bone interface around the femur (red arrow), and posterior tibial osteolysis (blue arrow) on the MAVRIC SL image. MAVRIC SL demonstrates clear outline of polyethylene (red arrows) and posterior tibial osteolysis (blue arrow).

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Impacting patient care

Dr. Potter states that the surgeons at HSS are now requesting the "MAVRIC protocol" for imaging around MR Conditional implants. Recently, she presented data to the Hip Society and says, "MAVRIC really altered their perception of MR joint imaging. For the first time, we can look inside the reconstructed hip joint and surgeons can obtain the information they need non-invasively and in less time." She also suggests that surgeons can effectively use MAVRIC SL images as visual aids in directly explaining to patients why they are in pain.

"Artifacts were part of the problem, but another challenge was that we had to reassure clinicians that MR imaging around metal‡ is safe, as long as you provide an appropriate level of safety screening," Dr. Potter adds. For example, all MR imaging patients change out of their street clothes, are screened, and pads are utilized for the elbows and between the legs. Approximately 2,500 patients have been scanned with MAVRIC SL under an IRB at HSS with no adverse events or reactions caused by the presence of metallic‡ implants.

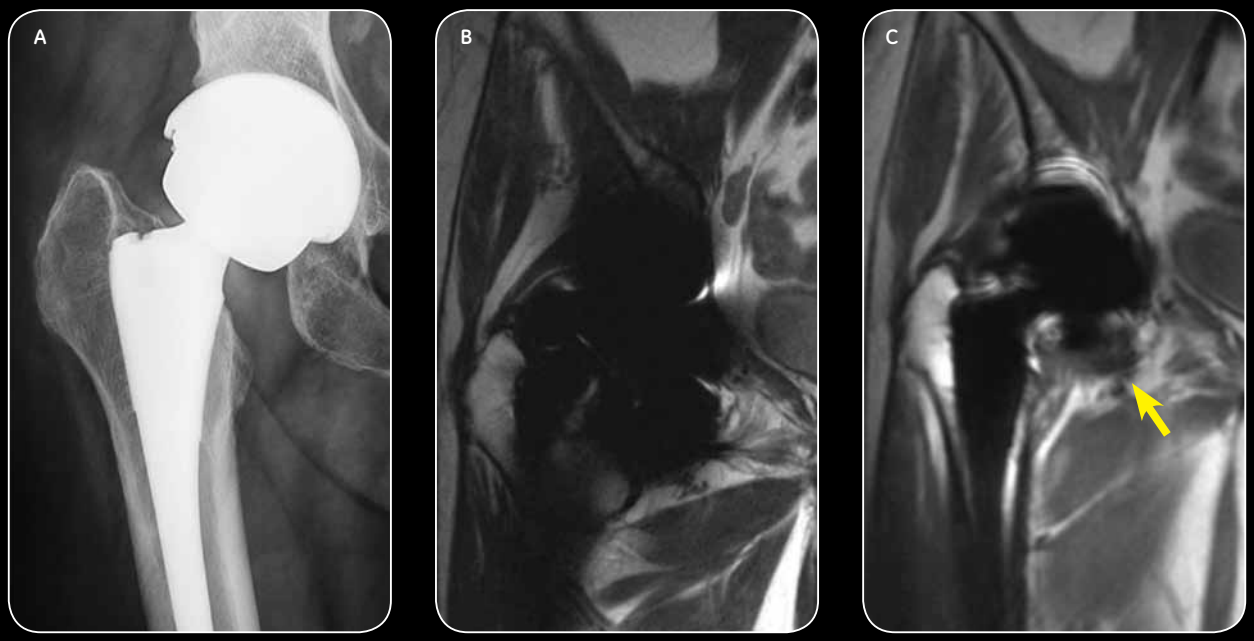
Today at HSS, MAVRIC SL is part of the imaging protocol for all patients with potential complications related to implants. "MAVRIC has completely changed our diagnostic ability," Dr. Potter says. She acknowledges that reading the images has a learning curve—similar to looking at a chest X-ray for the first time; with each patient study, Dr. Potter fine-tunes her base knowledge and discovers new ways to impact patient management.

For example, several recently published papers examined 12 MR characteristics using FSE and MAVRIC SL techniques on patients with metal-on-metal‡ implants.[9,13,14] "With MAVRIC (SL), there was a little artifact around the neck of the hip arthroplasty, yet we could measure synovial joint expansion and found that it highly correlated with a high specificity and sensitivity for the degree of tissue damage encountered at revision surgery as well as the histologic scores for the degree of tissue damage denoted by samples obtained at revision. The sensitivity and specificity for the MAVRIC MRI was higher than that reported for serum metal‡ ion levels," Dr. Potter explains. "It allows us to measure the thickness of the synovium and that is very important."[9,13,14]

"We can't cure osteoarthritis...the only practical solution for many patients is joint replacement," she says. "These are patients who want to remain active, and so our ability to evaluate those implants is paramount. And these surgeries are being performed in younger patients; so as the implants age along with the patient, there is an increased risk of complications. MAVRIC (SL) is a non-invasive, non-ionizing radiation exam in a magnet—no needles, no injections."

In fact, Dr. Potter believes that any symptomatic patient with an at-risk implant should be scanned with MAVRIC SL. "Published data show that you cannot use symptoms alone to determine adverse tissue reaction to an implant—it is not sufficient to drive management, and clinicians will miss it. If we do not catch these reactions early, the patient is subjected to prolonged pain and potentially more tissue damage encountered at revision, which is associated with higher morbidity. That risk is far greater than performing a MAVRIC SL exam."

Case study



Images courtesy of Hospital for Special Surgery, New York.

Figure 3. Patient with adverse tissue reaction is not apparent on X-ray (A) or conventional MR (B). Diagnosis was made based on MAVRIC SL image (C).

Adverse Local Tissue Reaction

A 65-year-old with severe pain over several months duration, following total hip replacement three years earlier (metal-on-metal‡). No pathology seen in X-Ray (Figure 3A) or conventional MR (Figure 3B). MAVRIC SL (Figure 3C) showed clear evidence of an abnormal synovial response indicative of an adverse tissue reaction (yellow arrow).

The patient was indicated for a revision surgery. S

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Hollis G. Potter, MD, *is Chief, Division of Magnetic Resonance Imaging and Director of the MRI Laboratory at the Hospital of Special Surgery (HSS) in New York. Dr. Potter is a Board-Certified Radiologist specializing in Musculoskeletal MR Imaging since 1990. She has published 155 scientific articles and 53 book chapters. Dr. Potter has presented and been invited to speak locally, nationally, and internationally at orthopaedic and radiologic scientific meetings. She is funded for MR research in both clinical and basic science projects. Dr. Potter is nationally and internationally recognized for her expertise in developing MR applications for orthopaedic conditions. Dr. Potter has been listed in the Consumer's Research Council of America: Guide to America's Top Radiologists. First Edition, 2002-2003 and New York Magazine's "Best Doctor" every year from 2003 to present.*

Hospital for Special Surgery, *Founded in 1863, is the nation's oldest orthopedic hospital. More than 25,000 surgical procedures are performed annually. HSS performs more hip surgeries and more knee replacements than any other hospital in the nation. The hospital is nationally ranked #1 in orthopedics, #3 in rheumatology, and #10 in neurology by U.S. News & World Report (2012-2013).*

MR-GUIDED FOCUSED ULTRASOUND FOR PALLIATION OF PAINFUL BONE METASTASES

Globally, 1.2 million people suffer from bone metastases, a painful condition that often affects the pelvis, ribs, and spine first. Bone metastases—the third most common site for metastatic cancer—are the result of cancer cells breaking away from their primary site and spreading to other parts of the body. According to the American Cancer Society, more than two out of three breast and prostate cancers that metastasize to other parts of the body spread to the bones. Of lung, thyroid, and kidney cancers that metastasize to other parts of the body, about one out of three will spread to the bones. Studies have shown that 90% of patients with advanced cancer experience severe pain, and this pain is often due to bone metastases. Unfortunately, multiple studies document that as many as 50% of patients may be undertreated for pain.

For 50% to 80% of patients suffering from this painful condition, external beam radiation therapy (EBRT) can provide significant palliation. However, EBRT fails to provide pain palliation in approximately 35% of patients referred for the therapy. In addition, there are also a number of patients who either cannot or do not want to undergo EBRT. For these patients, the only other option to alleviate their pain is narcotic medications—and most of these drugs have substantial side-effects including dependency.

The pain these patients endure can be severe and fairly constant, even at night, causing a significant impact on their quality of life. Fortunately for these patients, the FDA recently approved a procedure that has been available in Europe since 2007 and is clinically shown to reduce pain from bone metastases—and this can

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help patients reduce their need for pain medication. ExAblate MR-guided Focused Ultrasound (MRgFUS) from InSightec Ltd. (Tirat Carmel, Israel) and available on the Optima* MR450w 1.5T and Discovery* MR750w 3.0T wide bore systems from GE Healthcare is providing new pain palliation for bone metastases patients.

Since 2004, ExAblate has been used worldwide to treat uterine fibroids and provide fast symptom relief in more than 10,000 women. According to Jim Davis, CEO of InSightec, "This is the second FDA approval for the ExAblate technology and represents a significant milestone in our quest to expand the applications for this innovative, non-invasive therapy. It also demonstrates our continued commitment to bringing ExAblate MR-guided focused ultrasound into broad clinical use and improving our patients' quality of life."

This also represents the first foray into oncology for the technology. With the leap from interventional radiology, ExAblate embraces GE Healthcare's commitment to pursuing technology that goes beyond radiology and aids in treatment. Central to GE's "Beyond Radiology" initiative is the understanding that, while imaging technology has historically assisted in diagnosis of disease and injury, it can also play an important role in helping clinicians determine the biologic and functional response of cells and tissue to patient treatment.

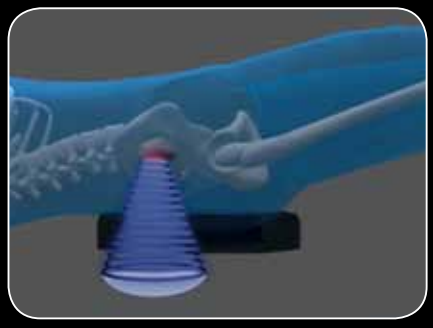


Figure 1. The Focused Ultrasound is readily absorbed by bone, primarily at the cortical and periosteal margin. Using a wide beam approach, the focused ultrasound beam intersects the bone cortex producing a broad area of heating at the periosteal margin. Neural pain fibers in the periosteum are destroyed, thus providing pain palliation.

How it works

There are a number of mechanisms responsible for the pain caused by bone metastases. One of the primary mechanisms is increasing pressure on the periosteal nerves from the growing tumor. ExAblate focally targets the nerves in the periosteum close to tumor and palliates the pain radiating from that site.

ExAblate combines therapeutic ultrasound waves with continuous guidance and treatment monitoring via MRI. The focused ultrasound energy ablates the nerves causing the pain, resulting in rapid reduction in pain. Physicians use the real-time MR data to plan and guide the therapy and monitor treatment outcome.

Bone absorbs acoustic energy very efficiently at 50-times that of soft tissue. Broad surfaces can be treated quickly with low energy levels to decrease treatment—in fact, treatment can be completed in just one session. For patients, MRgFUS for palliation of bone metastases provides results in just a few days and has an excellent safety profile: this non-invasive technique minimizes bone weakening and the risk for vasculitis, skin injuries, and fractures. Unlike EBRT, the technique does not exclude future treatments.

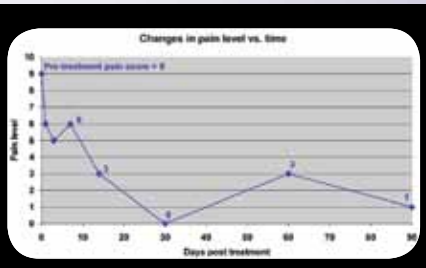
Results of the FDA clinical trial

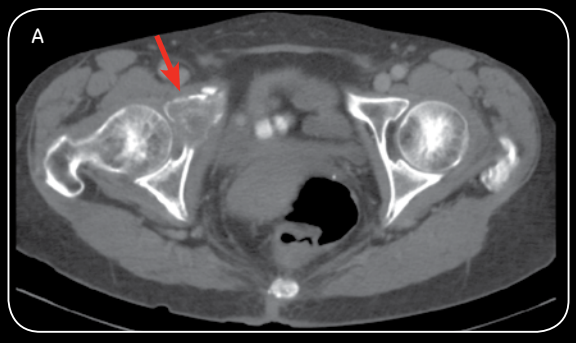
InSightec conducted an FDA Phase III randomized controlled trial in which MRgFUS was compared to sham, or no treatment. 150 patients participated in the trial; those in the sham group had the option to crossover. Results include:

- Mean worst-pain score fell from 7 to 5 in one day and dropped to 3.3 at one month, compared to a drop from 7 to 6.1 in the sham group.
- Pain improvement maintained for at least 3 months.
- 71% of patients reported significant pain reduction.
- 57% of patients reported reduction in opioid use.
- Minimal incidence of device-related serious adverse events were reported.
- Patients receiving real (not sham) treatment reported dramatic improvement in their quality of life.

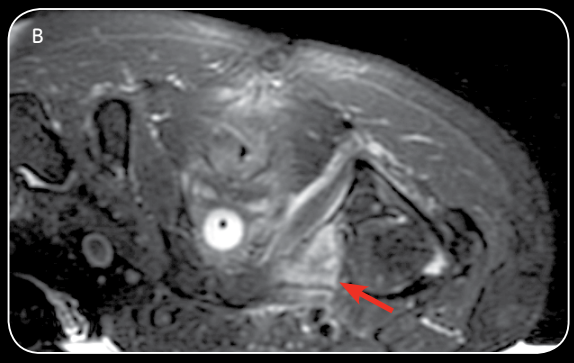
Joshua Meyer, MD
is an attending physician and Assistant Director of the Residency/Fellowship Training Program in radiation oncology at Fox Chase Cancer Center.

Figure 2. A 67-year-old with primary renal cancer. ExAblate treatment was targeted to the osteolytic lesion in the right pubis ramus. 17 sonications were performed. Post-treatment images (C, D) demonstrate a reduction in the lesion immediately after the procedure.





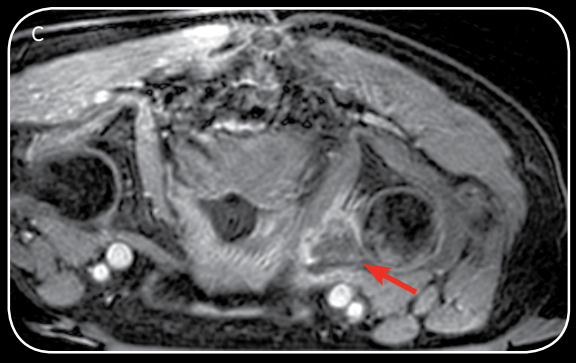
CT image



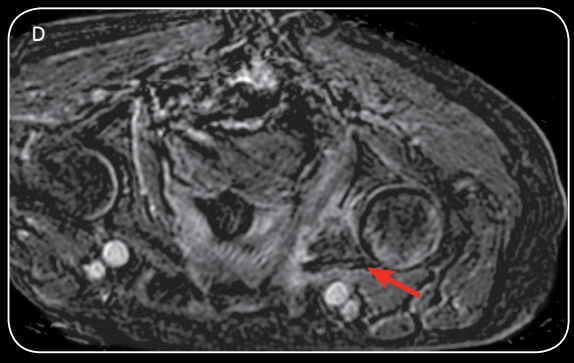
Axial T2w MR image

Images courtesy of Fox Chase Cancer Center, Philadelphia, Penn.

Immediately post treatment (prone position)



Axial T1w MR image



Axial T1w subtraction image

There were no unanticipated adverse device effects in this study for subjects in either the ExAblate-treated or Sham-treated groups. Overall, a total of four Significant Anticipated events occurred including one event of skin burn (third degree burn of 3 cm area), one event of leg neuropathy (leg pain after treatment), and two events of fracture (inherent complication of bone metastases regardless of their treatment or non-treatment).

Fox Chase Cancer Center (Philadelphia, Penn.) is an early adopter of the ExAblate system for pain palliation of bone metastases. Joshua Meyer, MD, says, "I have used ExAblate to treat a number of patients with bone metastases that were quite painful and we've had a great response in terms of people's pain resolving, resolving quickly and with minimal to no side effects at all."

ExAblate is the only FDA-approved MR-guided Focused Ultrasound system for treating uterine fibroids and pain related to bone metastases. It represents a new realm of technology that patients and providers are seeking: non-invasive, non-ionizing imaging that is ideal for use in an outpatient setting.

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Acknowledgment

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InSightec Ltd. *is privately held by Elbit Imaging, General Electric, and MediTech Advisors. Founded in 1999, InSightec developed ExAblate to transform MR-guided Focused Ultrasound (MRgFUS) into a clinically viable technology. ExAblate has won several awards for innovation and its potential to help mankind including The Wall Street Journal Technology Innovation Awards and the European Union's IST grand prize. TIME magazine recently named Focused Ultrasound as "one of 50 best inventions."*

InSightec

ADVANCING THE ROLE OF MRI FOR SPORT-RELATED TRAUMATIC BRAIN INJURY

By Roee Lazebnik, MD, PhD, Chief Medical Officer, GE Healthcare MR

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Traumatic brain injury (TBI) is an important risk associated with a variety of sports. It is estimated that in the US, emergency departments treat more than 170,000 sports- and recreation-related TBIs, including concussions, among children and adolescents per year. Further, the incidence of sports- and recreation-related TBI in this population has increased by 60% over the past decade.[1] Acute TBI may manifest with sensory, motor, and cognitive symptoms likely related to gross contusions and axonal injury. These are often visually apparent, using both conventional CT and MR techniques.

The term "concussion" is often utilized to refer to mild traumatic brain injuries (mTBI), such as sports-related TBI, often with no loss of consciousness, immediate sensory/motor symptoms, or clinical need for hospitalization. Unlike more severe forms of TBI, concussions are often associated with small or no obvious changes observed on conventional imaging. However, athletes who experience mTBI, including those who are not hospitalized or do not receive medical care, may experience symptoms for months or years beyond the date of injury. Some of these may be significant and lead to life-long complications, including physical, cognitive, and psychological changes. Thus, subtle changes in the brain, occurring in the sub-acute to chronic period, may be key to understanding these symptoms and their linkage to mTBI. These changes are likely associated with a variety of cellular and molecular-level mechanisms, such as altered proteostasis, that are presently not well understood and difficult to study both in context of detection as well as variable latency.[2]

MR is unique in its ability to provide a multi-parametric evaluation of the brain in a single imaging session. This includes the visualization and quantification of anatomical, perfusion, flow, metabolic, connectivity, and functional biomarkers. Such an approach is likely required as all of these parameters demonstrate at least some change, based on previous TBI studies. For example, a recent study demonstrated changes in working memory functional activity in mTBI patients, even when behavioral performance changes were not present, compared with controls.[3] Thus, a "whole brain" approach to evaluating mTBI is required, using a suite of imaging and analysis tools. In order to advance the application of MR imaging for TBI evaluation and ultimately patient management, these tools should be specifically optimized for TBI-related imaging.

GE Healthcare and the NFL are collaborating to improve athlete medical care and safety through the Head Health Initiative and Head Health Challenge. At the core of the partnership is a four-year, $40M initiative to advance the diagnosis and management of TBI using advanced MR technology. GE will team with world-class experts and research institutions to study the immediate and long-term findings associated with TBI using a multi-disciplinary "whole-brain" approach. This data will enable iterative optimization of novel MR techniques, analysis tools, and hardware cumulating in a next-generation scanner platform optimized for TBI imaging.

An improved understanding of the pathogenesis of TBI, particularly in context of long-term sequelae, will enable earlier diagnosis and management of these patients. The Head Health Initiative will facilitate the development of advanced MR-based imaging tools to support continued research in this field, particularly for sports-related TBI. Ultimately, the resulting innovations will benefit professional, amateur, and adolescent athletes, as well as the armed services, auto accident victims, and others.

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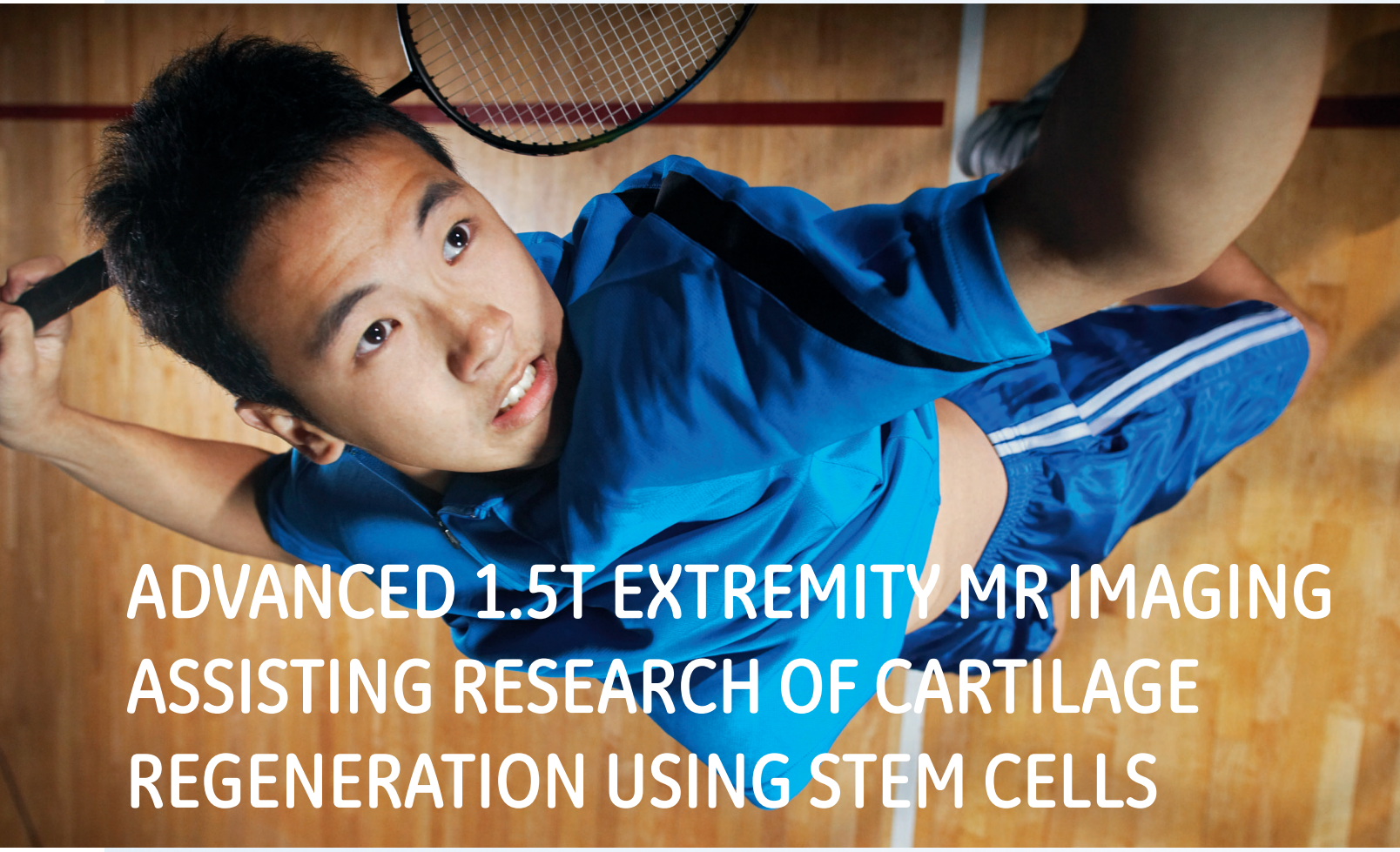

ADVANCED 1.5T EXTREMITY MR IMAGING ASSISTING RESEARCH OF CARTILAGE REGENERATION USING STEM CELLS

Kuala Lumpur Sports Medicine Centre (KLSMC) is a private hospital in Malaysia that offers sub-specialty management of sports medicine and orthopedic conditions of the shoulder, knee, hand, foot, hip, and spine.

Shahrin Merican, MBBCh, BAO (Ireland), FRCR (UK), MMedRad (UKM), AM

is Consultant Radiologist Kuala Lumpur Sports Medicine Centre (KLSMC) Sports Imaging.

Since its establishment in 2005, KLSMC has attracted patients and medical referrals from around the world. Arthroscopic and joint replacement surgeries are routinely performed at the hospital.

In May, 2011, the hospital's dedicated Sports Imaging department began utilizing GE Healthcare's 1.5T ONI MSK Extremity MR. As a direct result of this implementation, workflow was streamlined; resulting in an increased number of patients and a higher-quality MRI has enhanced the standard of care. The high field extremity MR scanner was also pivotal to a clinical trial conducted at KLSMC that is focusing on the utilization of stem cell therapy for treating damaged knee cartilage.

Khay-Yong Saw, MB ChB (Liverpool), MCh Orth (Liverpool), FRCS (Edinburgh)
is a Consultant Orthopaedic Surgeon at the Kuala Lumpur Sports Medicine Centre (KLSMC).

Stem cell research on cartilage regeneration

Degenerative changes to the joints occur when there is a breakdown of articular cartilage. Cartilage regeneration using the patient's own stem cells has made the treatment of complex cartilage injuries possible, especially at the knee.

According to Khay-Yong Saw, founder and senior partner of KLSMC, stem cells in adults act as a repair system for the body, allowing replacement of ageing and damaged cells in organs. "In adults, damaged tissue is usually replaced with scar tissue which loses most of its original function. Stem cell therapy has the potential to restore the original structure and function of the damaged tissue."

A 2011 study co-authored by Dr. Saw and his colleagues at KLSMC showed that it was possible to regenerate a better cartilage by injecting a combination of peripheral blood stem cells (PBSC) and hyaluronic acid (HA) into the defective areas following subchondral drillings.[1]

And, in showing that post-operative intra-articular injections of autologous PBSC with HA resulted in improvement in the quality of repair cartilage over the same treatment without stem cells,[2] the GE 1.5T ONI MSK Extremity MR was used to assess all post-operative repair cartilage.

Typically, harvesting is performed one week after arthroscopic subchondral drilling of the chondral lesions. To enable harvesting, a dual lumen catheter is inserted into the femoral vein. The catheter allows blood to be passed through a cell separator which filters out stem cells and returns the processed blood to the body. This procedure is called apheresis. The stem cells are prompted to move into the bloodstream using a hormone called G-CSF, a hormone produced by the body that stimulates the production of marrow stem cells which enter the bloodstream. A local anesthetic is used to minimize discomfort from the venous cannulation which is performed under ultrasound guidance. Once harvesting is complete, the catheter is removed and the stem cells can be used immediately for treatment or be cryopreserved for use at a later date.

Interval MR exams by 1.5T ONI MSK Extremity MR has shown satisfactory healing of the chondral defects including the subchondral bone. The MR images also clearly showed evidence of cartilage regeneration. This newfound innovative procedure is not limited to small isolated lesions but can be used to treat large, multi-compartment lesions, including "kissing lesions."

Perhaps more importantly for patients, the surgery is a single stage arthroscopic procedure followed by subsequent intra-articular injections of PBSC and HA. There is no second surgery or open surgery required, as in the case of other cartilage repair techniques. Stem cell therapy can also be extended to ligaments, muscles, and bone injuries, attesting to the pluripotential properties of PBSC.[3] Dr. Saw has treated some of the country's top athletes and weekend warriors alike with this cartilage regeneration technique.

Optimized workflow and improved clinical care

In addition to playing an important role in the stem cell research and cartilage regeneration at KLSMC, the dedicated 1.5T system provides KLSMC with an improved workflow, flexibility, and reliable anatomy-specific imaging capabilities. As a significant portion of the caseload at KLSMC involves the extremities, the system was the natural choice to facilitate MR imaging, not just of the knees, ankles, wrists, and elbows.

Arthroscopic images

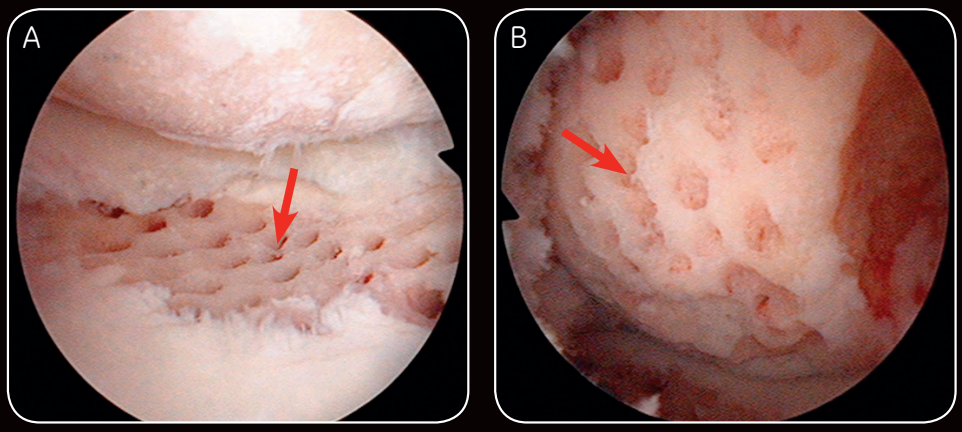

Figure 1. Arthroscopic image illustrating post-subchondral drilling over the lateral tibial plateau (A) and post-subchondral drilling of the lateral femoral condyle (B).

Post-operative MR

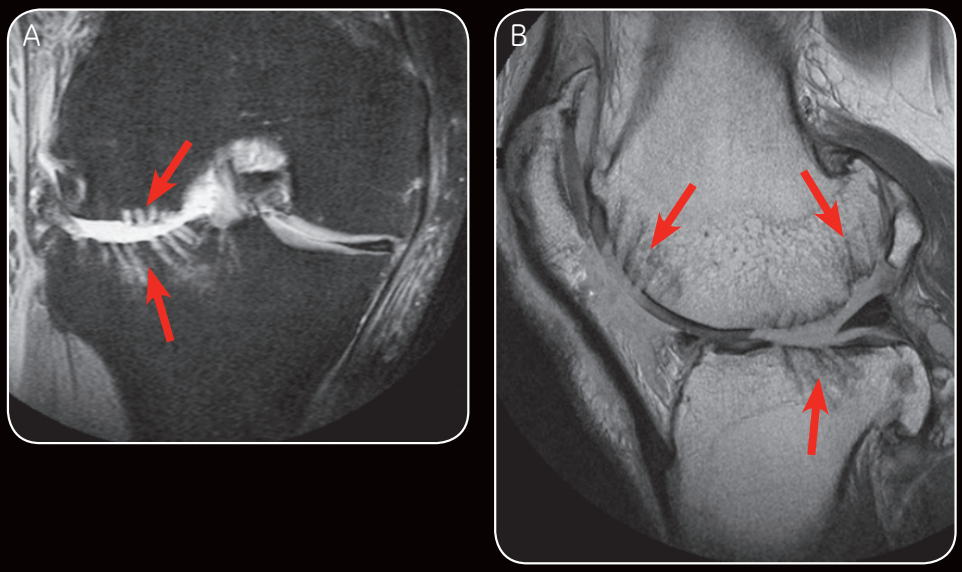

Figure 2. Early post-operative MR images: PDFS (A) illustrates subchondral drilling at the lateral femoral condyle and lateral tibial plateau. Sagital PD (B) shows areas of subchondral drilling.

Six-month follow-up

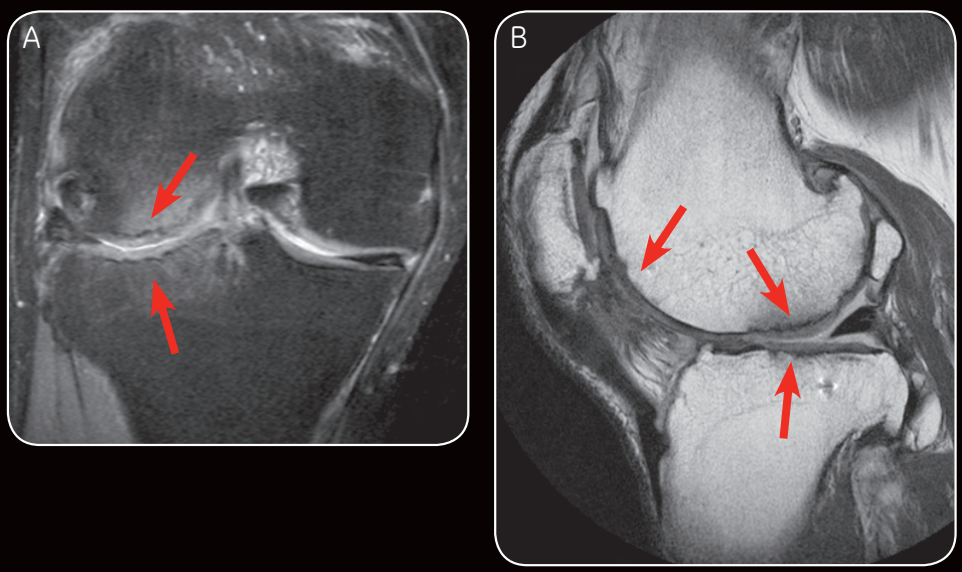

Figure 3. Appearance on MR image at six-month follow-up demonstrates satisfactory repair cartilage and minimal subchondral oedema (A). Sagital PD at six-month follow-up also demonstrates satisfactory repair cartilage (B).

> "The use of a high field extremity MR scanner is the key in enabling us to better visualize the repair cartilage."
>
> *Dr. Khay-Yong Saw*

"Since implementing the GE 1.5T extremity system, we are now able to conduct examinations on very specific cases of sports-related injuries," says Dr. Shahrin Merican, consultant radiologist at KLSMC.

Besides being able to handle a greater caseload, the system has also helped reduce patients' waiting time and allow same-day imaging to be performed at KLSMC. "Approximately 25% of our patients come from other parts of Malaysia and overseas, and our ability to provide same-day imaging at the first clinic visit is a significant convenience for them," says Dr. Merican. "Same-day imaging provides earlier diagnosis and allows prompt formulation of a treatment plan."

This increased level of patient volume has improved productivity and increased the economic benefit. The system provides high-quality imaging at a fraction of the price of conventional whole body MR scanners. The compact system has a much smaller footprint, taking up less floor space and uses less electricity for significant cost savings.

Dr. Merican adds, "What's also important from a clinical care perspective, is the patients' level of comfort and ease-of-mind when undergoing their MR scans. We find that our patients have been impressed by the small size and quiet operation of the scanner. Patients are much less intimidated by the machine, and claustrophobia is rarely an issue."

The implementation of the system has ultimately contributed to a more conducive clinical and research environment at KLSMC. Dr. Saw explains the installation of the extremity scanner shows promising results for the assessment of cartilage regeneration. "The use of a high-field extremity MR scanner is the key in enabling us to better visualize the repair cartilage," he says. Regarding clinical use of the 1.5T extremity scanner, Dr. Merican adds, "By allowing us to make confident diagnoses through the use of a reliable, patient-friendly scanner, we expect to gain from an increase in the number of medical referrals resulting directly from the greater patient satisfaction that has been achieved."

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Dr. Shahrin Merican, MBBCh, BAO (Ireland), FRCR (UK), MMedRad (UKM), AM, *is Consultant Radiologist at KLSMC Sports Imaging. He works closely with Dr. Saw in the arthroscopic correlation of radiological findings.*

Dr. Khay-Yong Saw, MB ChB (Liverpool), MCh Orth (Liverpool), FRCS (Edinburgh), *is a Consultant Orthopaedic Surgeon at the Kuala Lumpur Sports Medicine Centre (KLSMC). His field of interest is in arthroscopic surgery of the knee, in particular the use of stem cells to regenerate articular cartilage.*

Kuala Lumpur Sports Medicine Centre (KLSMC) *in Kuala Lumpur, Malaysia is a one-stop private hospital for sports injuries. Services include orthopaedic surgery, physiotherapy, MRI imaging, and hydrotherapy. KLSMC employs the latest technology in sports medicine and specializes in conditions of the shoulder, knee, hand, foot, hip, and spine. Operations such as arthroscopic surgery and knee replacements are routinely performed.*

FIRST MR + PET/CT TRIMODALITY IMAGING INSTALLATION PLANNED IN LATIN AMERICA

GE Healthcare's new trimodality imaging system is designed to capture high-quality images from MR and PET/CT scanners, then fuse them with Integrated Registration* software.

Trimodality imaging is intended to be a sound investment for researchers and multi-specialty hospitals interested in combining functional and structural information to enhance patient care. For example, researchers and clinicians can access new technology to potentially improve image quality, see fine vessel detail, visualize cardiac anatomy and function, detect small lesions, monitor response to therapy, and forge a smarter path from clinical research to patient care. Facilities can utilize all three leading-edge PET, CT and MR technologies—together or individually—providing unparalleled choice, flexibility, and clinical value.

GE Healthcare celebrates trimodality imaging as a step to help facilities improve the level of care for their patients. Here, Brazil's Dr. Leonardo Normanha at Instituto Goiano de Radiologia (IGR), who will be the first to install the new system in Latin America—applauds trimodality imaging as an excellent addition to his radiology department.

Q How did you decide to install the new trimodality MR + PET/CT technology at IGR?

A Actually, I wasn't searching for it. The trimodality imaging system was featured at the 2012 Radiological Society of North America conference, where I had the opportunity to see it for the first time. This system is very interesting because it makes an association between MR and PET/CT images in an economical way, and with an improved technical result. I believe that it has a very good chance of becoming more popular in the international market.

Q How do you intend to offer the new technology to patients in Brazil?

A Initially, I'm offering the trimodality imaging technology without changing costs to the patient or the convening institution, because the exams will provide IGR with the opportunity to become better acquainted with the new system.

Q What is the expected benefit in your region and for IGR?

A The biggest benefit is that this new technology will put us on equal ground with major imaging centers worldwide. It's the dream of every radiologist to have PET images fused with MR images, because the anatomic quality is far superior to CT—except, perhaps, with examinations of the chest and bones. The MR + PET/CT technology places IGR in the vanguard position regarding innovations in the market. I think it's really important to establish your facility as a leader in the best that the market has to offer. Having the best may not assure success, but it's the key to finding it.

Leonardo Martins Normanha, MD
Technical director of diagnostic imaging at Instituto Goiano de Radiologia.

Q Why did you select a trimodality imaging system from GE Healthcare?

A I chose GE because the company is a long-standing partner of ours, and I have very close access to all of the people who work there. This relationship has provided me with tranquility and great confidence in my investments. I believe that GE can help me accomplish my goals. I began my partnership with GE eight years ago, and the results were very positive.

Q How does the new trimodality system differ from the old equipment used by the IGR?

A We see a new perspective emerging, thanks to better examination quality and anatomy definition. Anatomy is everything in a test of imaging, and trimodality is tops in terms of improved image quality.

Q How does the merger of three different modalities help in routine exams?

A It will assist me daily because it gives me more information. Our responsibility in performing exams and making reports grows every day, and new technologies like this help us provide patients with more accurate information and diagnoses.

Q When it comes to trimodality imaging, what do you envision for the future?

A I don't think there will be separate imaging and nuclear medicine clinics—they'll integrate to form a single unit working side-by-side.

I work in an institution that has excellent exam quality and thanks to this new technology, I am very happy about the way I can do MR exams—now and in the future. I'm 60 years old and I did 35 years of residency... never in my life did I think I'd work with so much technology. When you have a lot more to imagine than to remember, it is a sign that you are still part of the process of struggle. And it's brilliant. S

Leonardo Martins Normanha, MD, *was born in Belo Horizonte, Minas Gerais. He graduated in Medicine from the University of Minas Gerais in 1977. He was a Volunteer Intern in the Hospital Santa Casa de Misericórdia of Belo Horizonte and Hospital das Clínicas of UFMG in 1976, performing ancillary surgery activities, ambulatory, minor surgery, and other duties. He interned in Radiology at Instituto Goiano de Radiologia and at the Instituto de Radiologia Manoel de Abreu, in Rio de Janeiro. He did his residency in radiology at the Hospital da Ilha do Fundão (UFRJ) in 1979 and did a residency in computed tomography and magnetic resonance imaging in the Hospital Rotchild- Paris in 1980. Today, he is the area Technical Director of Diagnostic imaging of the Instituto Goiano de Radiologia and is also responsible for implementing the publication of the Instituto de Radiologi, which comes out three times a year.*

The Instituto Goiano de Radiologia (IGR), *located in Brazil, was founded by José Normanha, MD, in 1952. The facility was the first to offer high-field MR and multislice CT in the Goiás. In 2013, IGR's three units served 1.2 million patients.*

EVALUATING PHENOTYPES OF NAFLD PATIENTS IN INDIA, US

Needle-Free MR applications used to diagnose liver disease in children and adults of all shapes and sizes

The prevalence of obesity, diabetes, and non-alcoholic fatty liver disease (NAFLD) is rising in the developing world as a result of economic prosperity and the westernization of diet and lifestyle. This prevalence is related to the growing epidemic in childhood obesity during the past decades. Currently, pediatric NAFLD is the primary form of liver disease among children.[1]

Additionally, Indian men are known to have a high prevalence of NAFLD.[2] However, unlike the common obese phenotype of the US patient with fatty liver disease, a 2010 rural population study of Nagari Gram Panchayat in the Birbhum district of West Bengal showed 8.5% of the population had fatty liver without being alcohol consumers, overweight, or obese. Furthermore, 59% of individuals in that study were either agricultural workers or manual laborers and, therefore, likely engaged in considerable daily physical activity.[3]

These data support the concern of an increased risk of NAFLD, diabetes, and cardiovascular disease among "normal weight" (by Western standards) residents of Asia—in particular among residents of India. In developing countries, physicians such as Abhijit Chowdhury, MD, School of Digestive and Liver Diseases in Kolkata, India, have concluded that a non-obese, even non-overweight, supposedly physically active individual, with or without a bulging waistline, can have a fatty liver accompanied by a slightly elevated body adiposity.

Vitals...

Chronic viral Hepatitis due to Hepatitis B and C is the most common cause of cirrhosis and hepatocellular carcinoma in developing countries.[6]

When it comes to US patients with NAFLD, Scott B. Reeder, MD, PhD, Section Chief of MRI and Cardiovascular Imaging at the University of Wisconsin, concurs. "It's not just obese patients who have fatty liver disease in the US. Patients with metabolic syndrome or type 2 diabetes, who are just slightly overweight, can have NAFLD. It's also closely linked with insulin resistance. NAFLD is not just characteristic of obese patients, although we certainly see it in higher proportions in patients who are obese."

An emerging problem

In NAFLD, triglyceride accumulates within hepatocytes, which is considered to be the hepatic manifestation of metabolic syndrome. It is a distinct clinico-pathologic entity characterized histologically by a spectrum ranging from isolated steatosis to steatohepatitis and cirrhosis, and even hepatocellular carcinoma. Identification of fatty liver should also prompt the clinician to search for associations with diabetes mellitus, hypertension, and hypertriglyceridemia. Many patients with fatty liver have no symptoms or signs of liver disease at the time of diagnosis, and the first indication of steatosis is often found on cross sectional imaging. In other patients, fatty liver can be the cause of hepatomegaly and elevated liver enzyme levels, prompting a sonographic study directed specifically at the liver.

Although viral infections like Hepatitis B and C are the predominant cause of liver disease in India, NAFLD is an emerging problem. It's expected to be responsible for consumption of a significant proportion of healthcare facilities in the near future. As such, Dr. Chowdhury and others decided to study the community burden of liver disease, specifically NAFLD, in 2006. To their surprise, their study found a significant prevalence of NAFLD in 8.7% and cryptogenic cirrhosis, a sequalae of NAFLD, in 0.2% of their study population. In the third phase of the study, they estimated the hepatic fibrosis and cholesterol accumulation in patients with significant liver disease by transient elastography and liver biopsy. Interestingly, those with NAFLD were not necessarily obese.

Furthermore, their 2010 study found a significant prevalence of NAFLD and cryptogenic cirrhosis in a predominantly poor, non-obese, non-sedentary population. Abdominal obesity, being overweight, dysglycemia, rising income, and a normal BMI were found to be independent risk factors of NAFLD in the population.[3] "As a result of these studies, the stereotypical image of a person with NAFLD needs to be re-evaluated—especially in the developing world," comments Dr. Chowdhury.

According to the American Liver Foundation, NAFLD tends to develop in people who are overweight or obese or have diabetes, high cholesterol, or high triglycerides. Rapid weight loss and poor eating habits also may lead to NAFLD. However, some people develop NAFLD even if they do not have any risk factors, such as obesity. NAFLD affects up to 25% of people in the United States.[4]

Challenges of addressing NAFLD

Dr. Reeder says that one of the challenges in addressing NAFLD is the length of time it takes for the disease to progress. "It takes many years, maybe even decades, for patients to progress from isolated steatosis all the way through a progression of inflammation, liver injury, fibrosis, and cirrhosis, and even liver cancer. The long period makes it very difficult to identify those patients who are at risk of progression."

Not all patients progress from steatosis through the whole range of steatohepatitis. So the other hurdle is to identify if a patient has isolated steatosis or signs of steatohepatitis—the more aggressive subset of NAFLD. Another major challenge is to pinpoint those patients who have complications of NAFLD that are outside the liver. "Cardiovascular disease is probably the

biggest killer of patients with fatty liver disease. So identifying a patient with fatty liver disease is the first step, but then we also want to look at the other non-hepatic complications," he says.

Dr. Reeder continues, "Fatty liver disease is an independent risk factor of cardiovascular disease, independent of having diabetes or obesity. The exact relationship and the exact link is not well understood. It's very interesting to identify those patients who have fatty liver disease, because they will be at elevated risk of cardiovascular disease, subsequently identifying which of those have complications. This is of great clinical interest and it is certainly a challenge."

Needle-free diagnosis

So, how are these patients diagnosed? Even though liver biopsy is considered to be the "gold standard" for the diagnosis of NAFLD, it has its limitations, including risk, high cost, and invasiveness.[5] As there is an increase in the number of patients necessitating liver biopsy for fat quantification and assessment of significant liver disease, Dr. Avik Bhattacharyya, MD, Division of Radiology of School of Digestive & Liver Diseases, prefers to assess fatty liver in a needle-free, non-invasive way by using MR imaging. Other non-invasive techniques such as sonography and CT have been used to detect fatty liver. The reported sensitivities and specificities are 60–100% and 77–95% for sonography, 43–95% and 90% for unenhanced CT, and 81% and 100% for chemical shift gradient MR.

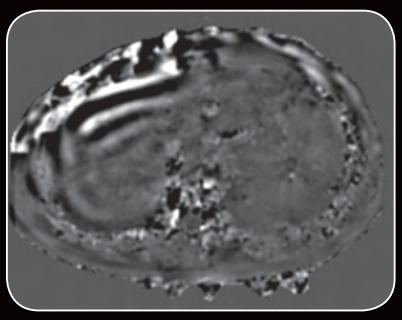
At the School of Digestive and Liver Diseases, Dr. Bhattacharyya and Dr. Chowdhury have opened a new dimension in the treatment of patients who have complicated gastrointestinal and liver diseases with the Signa* HDxt 3.0T from GE Healthcare. This MR system is an example of GE Healthcare's mission to Humanize MR in India—continuing to provide exceptional technology while optimizing access to needle-free liver assessment for patients.

"MR imaging is typically a non-invasive technique that can identify intracytoplasmic lipids and plays an important role in estimating the prevalence of NAFLD and cryptogenic cirrhosis in our predominantly poor and non-obese population. It helps illustrate similarities and differences between NAFLD in the developing world and NAFLD in the West—and portraying the long-term risk of adverse outcomes in the form of cryptogenic cirrhosis, cardiovascular disease, stroke, or cancer," says Dr. Chowdhury.

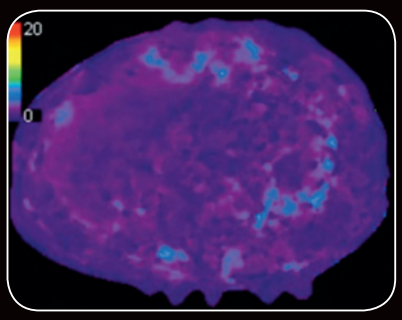
"We hope that improvement and refinement of this diagnostic modality will make it suitable for routine clinical application in the management of patients with NAFLD."

Case 1

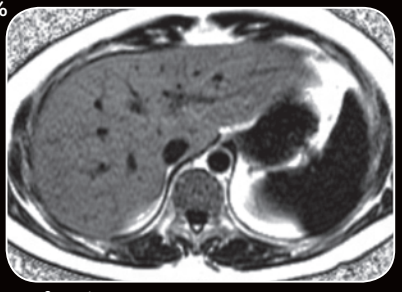
27-year-old with increased AST (79) and ALT (241) and a BMI of 27 Kg/m^2. Fat-fraction image shows 28% fat while MRE images show a stiffness of 1.9 kPa. Biopsy confirmed grade 3 steatosis with no evidence of steatohepatitis.



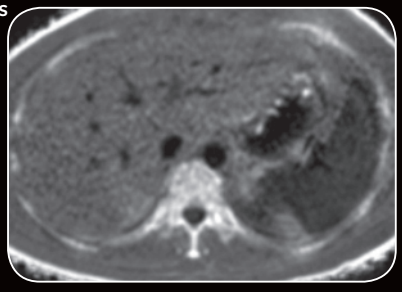
MRE Wave Image



Stiffness Map



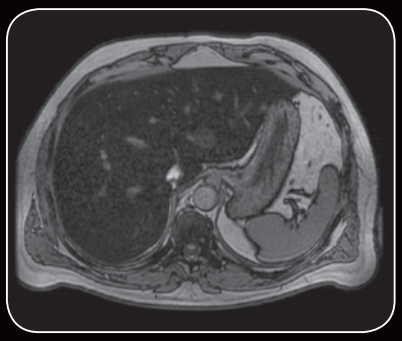
Fat-fraction Map



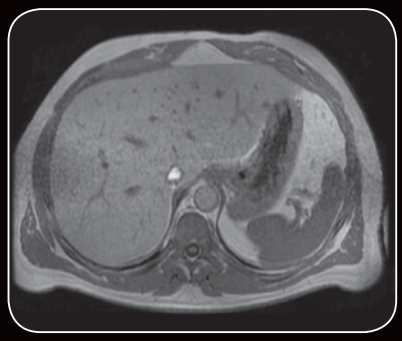
R2* Map

Case 2

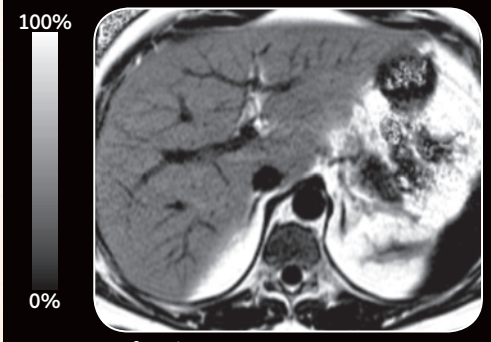
46-year-old with elevated AST/ALT. Patient had a 36 lb weight gain in 4 years with presumed NAFLD. However, after acquiring IDEAL IQ (Fat-fraction Map) patient was confirmed with nonalcoholic steatohepatitis (NASH). The liver shows a 43% fat content while the MR Touch image shows 3.5 kPa. Biopsy confirmed steatosis and fibrosis consistent with NASH.



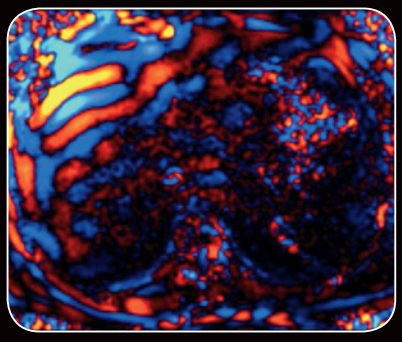
Opposed-Phase



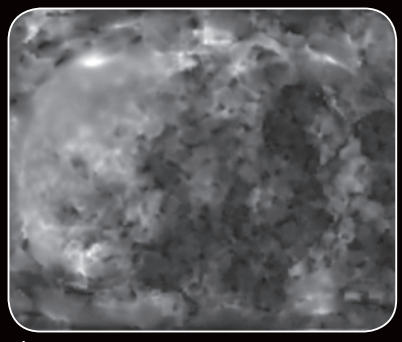
In-Phase



Fat-fraction Map



MRE Wave



Elastogram Map

Insight...

In collaboration with scientists at GE, Dr. Reeder developed IDEAL IQ, an MR-based technique that provides volumetric whole-liver coverage in a single breath-hold and generates estimated T2* and triglyceride fat fraction maps in a non-invasive manner. Brought to market by GE Healthcare, IDEAL IQ is intended for breath-held abdominal imaging to evaluate diffuse liver diseases such as hepatic steatosis of the liver and corrects for challenging confounding factors such as T2* decay.

He suggests four scenarios where IDEAL IQ could be especially beneficial for NAFLD patients. The first is for those who are at high risk; for example, obese adolescents or children for whom early detection of fatty liver disease would be critical. Additionally, distinguishing NAFLD from the more aggressive non-alcoholic steatoHepatitis using a combination of IDEAL IQ and MR Touch—an application developed by GE Healthcare with the Mayo Clinic (Rochester, Minn). It uses acoustic waves to identify variations in tissue stiffness. This provides an elastrogram, an anatomical depiction of the tissue stiffness of the liver, offering additional input to help radiologists and gastroenterologists make informed decisions about treatment.

Furthermore, from a research or clinical trial perspective, IDEAL IQ could be helpful with drug studies—not only from an efficacy point of view as a biomarker of fatty liver, but also from a toxicity point of view. For example, with a drug completely unrelated to metabolic syndrome and diabetes, IDEAL IQ could help determine if fatty liver is a potential side effect. Lastly, in the clinical domain, IDEAL IQ could assist physicians in tracking efficacy of interventions such as weight loss or bariatric surgery.

Where do we go from here?

Today, Dr. Chowdhury, Dr. Bhattacharyya, and other Indian physicians are engaged in defining the phenotype of NAFLD in non-obese subjects, but there are still so many questions to answer—mostly pertaining to the similarities and differences that might exist between NAFLD in the developing world and NAFLD in the West. For example, will the long-term risk of adverse outcomes in the form of cryptogenic cirrhosis be similar? What will be the risk of cardiovascular disease, stroke, or cancer? Will the pathophysiological mechanisms be the same?

Additionally, they're interested in finding out whether the NAFLD phenotype in the study population is representative of other ethnic groups living in other developing countries. They are planning to study its genetics to try to uncover the factors that predispose Indians to NAFLD even with a clinically subtle increase in total body adiposity. When applicable, they intend to use MR to help determine the answers.

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The School of Digestive and Liver Diseases at the Institute of Post Graduate Medical Education and Research *in Kolkata, India is dedicated to patient care and research activity in the fields of gastrointestinal and liver disease. Different departments such as hepatology, the Centre for Liver Research, the Division of GI and Liver Radiology, and the Division of GI and Liver Pathology work in a concerted way. The facility is engaged in both laboratory and community research activities in the field of hepatology.*

Scott B. Reeder, MD, PhD, *is the Section Chief of MRI and Cardiovascular Imaging, and Director of the UW clinical MRI fellowship. He joined UW-Madison in 2005 from Stanford University where he completed his radiology residency and a fellowship in abdominal and cardiovascular imaging. He completed medical school at Johns Hopkins in Baltimore, where he also received his Masters and PhD in Biomedical Engineering. He received his BScE in Engineering Physics at Queen's University in Kingston, Ontario. He is also the Director of the UW Liver Imaging Research Program. Specific areas of research interest include development of new MR methods for quantification of abdominal adiposity, liver fat, liver iron overload, and other features of diffuse liver disease, quantification of perfusion in liver tumors, hemodynamics of portal hypertension, and the use of new contrast agents in liver and biliary diseases.*

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