SIGNA

Pulse of MR

Autumn 2012

RSNA Edition

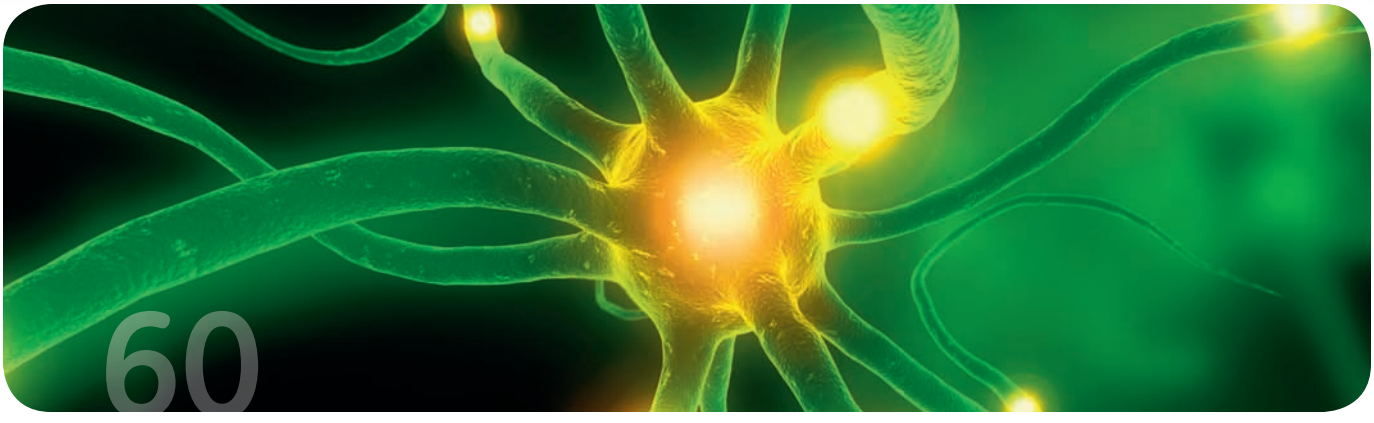
Volume Thirteen

WE HEARD THE PATIENT.

HUMANIZING MR

Outside the Bore

In Practice



Case Studies

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WELCOME

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This summer, Jacques Coumans, PhD was named Chief Marketing Officer for GE Healthcare Global MR. Prior to accepting the CMO role, Jacques led the Premium MR and Interventional business since 2009 and has had experience in engineering, sales, and medical imaging over the course of his career. Jacques is an avid history and architecture lover and is a founding member of the band MROX. As an active member of the ***SIGNA Pulse of MR*** Editorial Board, feel free to reach out to Jacques at signa.pulseofmr@ge.com.

Dear Friends,

It is with pleasure that I present to you this new issue of ***SIGNA Pulse of MR***. In my new role as Chief Marketing Officer of GE Healthcare's Global MR business, I consider it my job to build the coolest MR brand on the planet. We at GE strongly believe that the ultimate consumer of healthcare—the patient—should be the measure of the technological choices we make. GE has underlined this direction by choosing Humanizing MR as our mantra.

As an MR veteran, I can say with first-hand experience that the MR industry has not typically put patients first. GE is working to change this. Patients of all ages deserve solutions adapted to their differing bodily habitus and disease symptoms, because not all of us are finely-tuned machines like the athletes at the 2012 London Summer Olympics. Speaking of, GE was the sole provider of MR imaging, putting injured athletes first by scanning them on advanced technology—the Discovery* MR750w 3.0T and the Optima* MR450w 1.5T, both equipped with the GEM Suite of coils. See page 74.

In addition, geriatric and pediatric (read, fetal and neonatal‡) MR procedures are on the rise, and GE plans to address the needs of each of these patient groups in special ways. You will find interesting contributions to pediatric MR imaging and research in this issue of ***SIGNA Pulse of MR***.

This year's RSNA theme, "Patients First," dovetails perfectly with GE's mantra of Humanizing MR. We will discuss new core products that will feature our new Caring Design—the Optima* MR360 Advance 1.5T‡ and the Brivo* MR355 Inspire 1.5T‡ (see page 52). The Optima MR360 Advance is designed to include the Needle-Free Suite of applications and the new 16-channel head and neck array. And of course, there will be the signature "Caring Hands" lighting, accentuating our focus on design.

And at RSNA 2012, we are thrilled to be demonstrating Silent Scan‡‡—technology that is designed to allow patients to undergo the MR exam in an even more relaxed fashion because it is engineered to eliminate the typical MR noise at the source. In another proof of patient-centric focus, we observed that MR has fallen short in evaluating the patency of artificial joints in the elderly population because of metal artifacts. With MAVRIC SL‡‡, GE has designed a metal artifact reduction technique intended to help this patient group significantly.

While at RSNA this year, check out our two Caring MR Suites—one for the 3.0T wide bore Discovery MR750w, the other for our unique extremity scanner, the Optima* MR430s. Now patients can play their iPad or iPod in the exam suite while they are being scanned. And their loved ones will just be a glance away.

So stop by our booth and see what progress we are making in the MR industry.

Jacques Coumans, PhD
CMO Global MR, GE Healthcare

iPad or iPod are trademarks of Apple Inc., registered in the US and other countries.
‡MR scanning has not been established as safe for imaging fetuses or children < 2 years of age. A physician needs to decide to scan pregnant or infant patients.

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 questions and comments on the magazine. We'd also like to hear your ideas for improving *SIGNA Pulse of MR*. Write to us at **signa.pulseofmr@ge.com.**

Q **I am an MR technologist, and I started receiving *SIGNA Pulse of MR* in spring of 2012. I really like the magazine, and I think that some of my tech friends would like it too. How do they subscribe?**

A Thanks for writing! We're glad you like the magazine and want to recommend it to your friends. Your friends can register for a free subscription of the magazine at our Web site at **http://www3.gehealthcare.in/en/Products/Categories/Magnetic_Resonance_Imaging/SignaPULSE.**

If you haven't done so yet, we suggest downloading our free app that allows you to view the magazine digitally on your smart phone or tablet. Depending on your electronic device, you can get the app at the Apple Store **(www.apple.com)**; or Android Market **(https://market.android.com)** or at **(www.amazon.com).**

The Editors of SIGNA Pulse of MR

Q **In the last few years, I have noticed that GE MR has released many different types of pulse sequences that really look interesting. How can I try these on my system before purchasing?**

A Great question. We at GE MR pride ourselves on the importance of the Continuum* packages for installed based scanners. This allows all of our customers to stay current with the latest technology at low cost.

For example, if you're on an HD scanner you can easily become current by upgrading to the Signa* HDxt Optima* Edition 23.0 based platform. This platform provides access to signature applications like LAVA Flex for robust body imaging with four contrasts in one scan, or 3D ASL, which allows non-contrast, radiation-free quantitative perfusion assessment of the brain. Also available are industry-proven applications like PROPELLER 3.0 to help eliminate artifacts due to patient motion and MR Touch (MR Elastography) for "needle-free" assessment of liver diseases.

Once on the Optima Edition 23.0 platform, we make it easy to test these applications through our "flex-trial" process. This way, you have the option to evaluate these applications before making your investment.

Vicki Hanson,
1.5T MR Marketing Manager, Americas

Q **What can I expect from the Discovery* MR750w with GEM system (a 3.0T scanner) if I have only worked on GE's 1.5T systems in the past?**

A You can be excited to welcome the advanced 3.0T technology to your department and to apply its many advantages to your patients.

Some of the routine clinical benefits of 3.0T imaging compared to lower field strength include improved fat saturation, more signal to noise, and increased spatial resolution. For more advanced techniques, you will see a better BOLD response for fMRI and better dispersion of peaks when evaluating neurological disorders or diseases with spectroscopy.

Whether you're in a hospital, busy outpatient center, or in an emerging global market, 3.0T technology with GEM can be leveraged to give you and your patients a better MR experience. Moving from 1.5T to 3.0T can allow you to reduce your scan times by reducing your NEX (NSA) values and decrease your echo spacing (for sharper images) with increased reception bandwidths. The GEM Suite can help improve the patient experience with coils that are lighter and easier to set up.

Troy Lewein,
MR Advanced Applications Leader

HAUSMANN IN THE HOUSE

In January 2012, Richard Hausmann, PhD, was named President and CEO of the global MR business for GE Healthcare. He joined GE after a successful career at Siemens, where he most recently led the Smart Grid Applications Company Project, structuring the new business opportunities with the integration of renewable energy and electric cars. From 2005-2010, he was the CEO for Siemens and North East Asia, including China. Prior to that role, he served in various roles in application development and marketing in MR, as well as the CEO of the global CT business for the Siemens Medical Solutions Group.

SIGNA Pulse of MR recently sat down with Richard to discuss his new role and vision for the future of GE Healthcare MR.

Q. What do you find most exciting about the future of MR technology?

Firstly, I am fascinated by the technology and the innovation, even after 30 years of clinical MR use. Secondly, the healthcare industry has truly globalized over the past decades. Rural areas in China, India, Latin America, and Africa have a need to use more advanced imaging technology, such as MR. They have somewhat different priorities in the feature sets, which calls for even more innovative solutions. I find it most exciting that we are working to deliver MR to customers everywhere around the world.

Q. What unmet imaging needs do you believe MR can fill?

MR applications are still evolving and new needs can be met. The whole area of functional MR imaging, dedicated disease applications, and treatment planning and monitoring with MR are all exciting topics. I see MR taking a greater role in more specialized scanning, such as pediatric or neuro, as well as cardiac. Our clinical applications enable our customers to perform specialized scans (such as MR elastography for fatty liver tests), all without dose while being non-invasive. We are working to continue to develop our technological offerings for customers working in more specialized areas like neonatal imaging.

Q. Will we see MR taking on a greater "therapeutic" role, e.g., MRgFUS and iOMRI suites?

I believe MR will play a more important role as a monitoring device for minimal or non-invasive therapies. MR has the necessary sensitivity, for example, for subtle temperature changes, as well as great flexibility for slice orientations. Needless to say, it is also very beneficial to do this monitoring without any ionizing dose exposure. Additionally, our collaboration with InSightec is another great example of combining two truly non-invasive technologies to treat uterine fibroids.

Q. What are radiologists and hospital administrators telling you they need from next generation MR systems? How is GE poised to deliver/fulfill those needs?

MR needs to be more intuitive for the operator and more comfortable for the patient…less complex. When it comes down to it, our systems need to be easier to operate with an instinctual user interface. And we are always thinking of additional ways to make the experience more calming and comfortable for patients. In the end, it's all about having the most innovative, reliable technology that enables our customers to diagnose and treat their patients with confidence.

Quick stats:

Personal info:
I am 52 years old. Married to my wife, Anna, for 27 years and we have two boys, Moritz (23) and Philipp (20).

Where were you born?
I was born in a little village in Northeast Bavaria, around 50 miles west of the Czech border. My father worked in the local steel industry there.

Where have you lived?
I'll work backwards. Milwaukee, WI; Erlangen, Germany; Beijing, China; Erlangen, Germany; Regensburg, Germany; Stony Brook, NY; Regensburg, Germany; Poppenricht, Germany.

Favorite food:
Nuremberg sausages.

Favorite drink:
Good red wine from Bordeaux or Tuscany.

Favorite movie:
The Bridges of Madison County.

How many languages do you speak?
I speak English and German (with a Bavarian accent) and picked up some Mandarin when living in China.

Favorite hobby/thing to do in your free time:
I love old Volkswagens (the Beetles). I collect and restore them, and drive them in good weather as much as I can. Right now I own eight, all built between 1943 and 1951.

Favorite book (or favorite author):
I do not read much; I am more of a listener and observer. But I really like Hermann Hesse and his book, "The Steppenwolf."

Words to live by (quote or mantra you embrace and live by):
"To create the possible, we have to constantly try the impossible" (Hermann Hesse).

What is one of the most interesting things about you (personally, not professionally)?
In 2009, I organized and led the so-called "Vintage Volkswagen Challenge," where we drove in old Volkswagens from Erlangen, Germany to Beijing, China. I drove my grey 1949 Beetle. It took the group approximately one month to travel over 8,000 miles through seven countries. It was truly the experience of a lifetime! (Check out http://vintage-volkswagen-challenge-2009.net).

Q. Looking back on your first year at GE Healthcare MR, what accomplishment are you most proud of?

Honestly, I am most proud of my team members all around the world and their accomplishments. The more I got to know people, the more I realized how much know-how and how many innovative ideas are in our MR team at GE. I think I unleashed quite a bit of this in the first year and we have started some very exciting projects in various directions.

Q. What are your high-level goals for GE MR?

I want GE MR to be the market leader again. We invented clinical MR and maintained market leadership for many years. Recently, our market share has fallen below No. 1 and our team is determined to reclaim this position. We are working diligently to develop the most technologically innovative scanners on the market that enable customers around the world to treat patients. And we will try completely new ways to design and develop in close partnership with our customers and future markets.

Q. Can you share your business strategy for the group?

My business strategy feeds into my goals, which are previously referenced. With the main goal of regaining market leadership, our strategy is simple: We will bring the best clinical solutions with great patient experiences at the right cost and quality, allowing MR to help billions of people around the world. And we will maintain a constant focus on our people, product, and processes—with our teams all around the globe!

MR NEWS

New Patient-centric Advancements

‡‡510(k) pending. Not available for sale in the USA.

GE Healthcare plans to offer two new 1.5T MR systems, representing the company's ongoing focus on the human element in MR. Each is designed to offer different benefits—to fulfill the needs of facilities and patients. The Optima* MR360 Advance‡‡ is engineered to bring into balance the advanced MR platform, combined with flexibility and efficiency. It should provide exceptional performance, a comforting design, and advanced clinical applications. Two of its most compelling features are intended to be the Needle-Free Suite of MR applications and the 16-channel head and neck array.

The technologically inspiring Brivo* MR355 Inspire‡‡ is designed to make imaging more practical and easy to use, as its full capabilities are intended to be comfortably within reach. It's engineered to be intuitive yet effective, intending to offer a renewed sense of confidence. See page 52.

500th Global Shipment of Optima MR360 and Brivo MR355

Two years after the joint launch of Optima* MR360 and Brivo* MR355 products, GE Healthcare announced a major milestone with the 500th shipment of these products combined, making the duo one of the fastest in GE MR history to reach this milestone. The Optima MR360, an ecomagination innovation (**www.ecomagination.com**), is designed to enable improvements in scan speed and image quality, all with a lower power consumption. This innovative technology offers a large patient volume with a large 48 cm field-of-view. This system enables optimized neurovascular, MSK, body, and cardiovascular applications.

The Brivo MR355 is part of the GE healthymagination initiative **(www.healthymagination.com)** to make advanced diagnostic technology more accessible and cost effective. Everything about the design of the Brivo MR355 1.5T contributes to providing high-quality imaging with an easy-to-use user interface that will help customers make definitive diagnoses for patients. Featuring a 48 cm field-of-view, OpTix technology, and the embedded Express coil, the Brivo MR355 is also upgradable to help customers reach MR goals while managing system costs. See page 63 to discover how the Brivo MR355 brought advanced MR to India.

DIGITAL DIVE
For more information: **tiny.cc/spa1215**

Autumn Radiation Oncology, Pediatric User Meetings

GE Healthcare's Global MR business held the second annual MR Radiation Oncology User Meeting in Atlanta in September 2012. The meeting offered key thought leaders an opportunity to participate in an ongoing global radiation oncology community, focused on shaping the future adoption of MR and improving patient care in radiation therapy. The topics included best practices, gaining consensus on optimal MR protocols, understanding remaining challenges, and emerging trends and prioritizing future GE Healthcare developments in the use of MR for treatment planning.

Pediatric MR includes fetal, neonatal, pediatric, and even adult patients. Imaging this delicate population requires unique combinations of MR technology and education. Such uniqueness brings attention to unmet needs in all aspects of pediatric MR imaging.

As an initiative to understand and create solutions to these unique pediatric needs, GE Healthcare held its first Global Pediatric MR User Meeting in Washington, D.C., in October 2012. The objectives of the event included connecting pediatric imagers from around the world, creating a pediatric community where clinicians and the GE Healthcare team learned from each other—demonstrating GE Healthcare's commitment to the continuing development of pediatric MR, sharing best practices, and developing committed relationships. The agenda included segments of neuro, neonatal, body, cardiac, and fetal imaging, presented by guest speakers.

The event included a Children's National Medical Center department tour, hosted by Raymond Sze, MD and his staff. The tour showcased a beautifully organized clinical space, which includes a Discovery* MR750, a Discovery* MR450, and an Optima* MR450w—in addition to an MR research lab that's pushing the frontier of fetal brain imaging.

DIGITAL DIVE
For exclusive digital-only content, including speakers and presentations from both user meetings, visit **tiny.cc/spa1219**

Updates Made to Get Creative

GE Healthcare has made updates to its Get Creative Web site, designed to give US customers easy access to downloadable marketing tools for their GE MR systems. The site includes system photography, clinical images, and other advertising and marketing materials intended for consumers and referring physicians. The updates include a new look for the site and refreshed kits for the Discovery* MR750w with GEM, the Optima* MR450w (with and without GEM), and the Signa* HDxt 1.5T systems.

One of the kits' bonus elements is an e-mail template for referring physicians. The e-mail tells referring doctors about the system's key benefits in a very concise manner. Vicki Hanson, Segment Marketing Manager for the Americas Team at GE Healthcare, says the e-mail templates were added to give facilities an easier way to advise doctors that new MR technology is available. Hanson is refreshing kits for other GE systems so that all customers have easy access to these valuable marketing tools.

DIGITAL DIVE
Visit the GE Get Creative Web site to see available marketing materials: **getcreative.gehealthcare.com**

New Insights on Ancient Disease

Pediatric cerebral malaria (CM), a common yet often fatal tropical condition, affects approximately 3 million children annually and is responsible for one-fifth of the deaths in children <5 years of age in Sub-Saharan Africa.[1] CM is defined as parasitemia and deep coma with no other coma etiology evident.

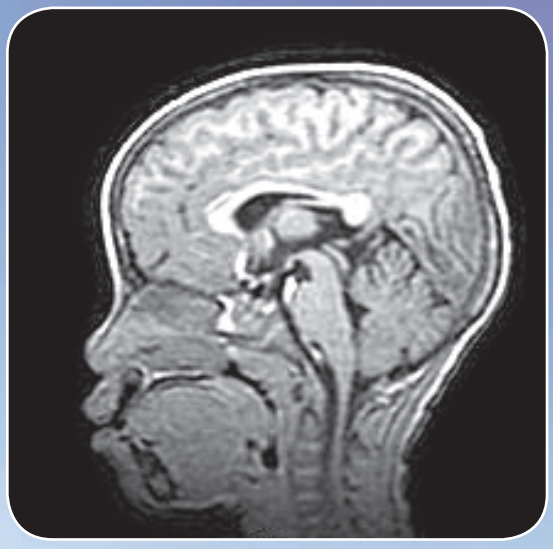
Blantyre, Malaŵi in Africa is a region exhibiting a high rate of fatal CM.[1] Unfortunately, advanced medical imaging technologies that can help with diagnosing and treating CM are generally unavailable in low income, tropical settings—despite the reality that neurologic disorders are disproportionately common in such environments.[2] MR was identified as the most promising imaging modality for visualization of the pathology likely to be detected in vivo.[3]

To enhance the clinical characterization of pediatric patients with CM through application of neurological MR methods, an MR imaging research facility was established in Blantyre.[3] GE Healthcare donated the Signa* Ovation Excite MR system—a 0.35T permanent magnet not requiring cryogen coolants. Using a permanent magnet, rather than a super-cooled magnet, simplifies the cost and logistical complexity of operations significantly.

There have been few neuroimaging studies of pediatric cerebral malaria; thus a prospective study of pediatric CM was conducted in Malaŵi to better characterize the MR features of this syndrome—comparing findings in children meeting a stringent definition of CM with those in a control group who were infected with malaria but who were likely to have a nonmalarial cause of coma.[1] Consecutive children admitted with traditionally defined CM were eligible for this study.[1]

MRI findings were compared between patients with and without retinopathy, to assess the specificity of changes for patients with very strictly defined CM. Of 152 children with clinically defined CM, 120 were retinopathy positive and 32 were retinopathy negative. Abnormalities much more common in the patients with retinopathy positive CM were markedly increased brain volume; abnormal T2 signal intensity; and DWI abnormalities in the cortical, deep gray, and white matter structures. Focal abnormalities rarely respected arterial vascular distributions. Most of the findings in the more clinically heterogeneous retinopathy negative group were normal, and none of the abnormalities noted were more prevalent in controls.[1]

Since MR became available, a new algorithm for care has been established. Acute MR imaging has afforded a number of patients the opportunity to undergo corrective surgery before permanent spinal cord damage ensues. The extraosseous extension and mass effect from TB can also be readily identified on MR which can greatly enhance surgical planning in clinically indicated cases. This substantive change in the routine clinical paradigm underscores the impact of the MR on clinical care.[2]



Distinctive MR findings present in patients meeting a stringent definition of CM may offer insights into disease pathogenesis and treatment. Resulting opportunities for studying common tropical disorders, such as malaria and schistosomiasis, in vivo are promising. The subsequent improvements in local patient care were expected and exceptional and include major revisions in basic care protocols that may eventually impact care protocols at facilities in the region that do not have recourse to MR.[2]

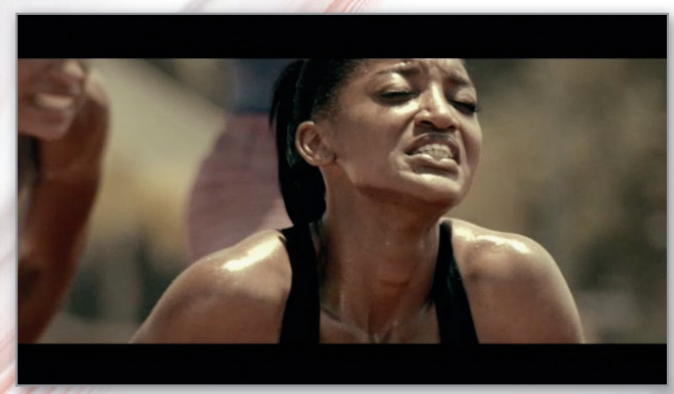
MR technology provides enhanced diagnostic options for the people of Malaŵi, improves medical education, and affords a rare opportunity for clinical and basic science researchers to utilize advanced imaging for medical research expanding our understanding of neglected and under-studied conditions unique to tropical, resource-poor regions.[2]

References

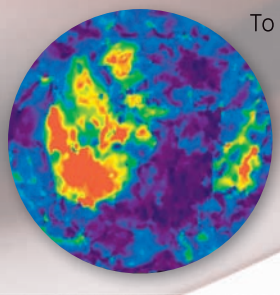
1. M.J. Potchen, S.D. Kampondeni, K.B. Seydel, G.L. Birbeck, C.A. Hammond, W.G. Bradley, J.K. DeMarco, S.J. Glover, J.O. Ugorji, M.T. Latourette, J.E. Siebert, M.E. Molyneux, T.E. Taylor. Acute Brain MRI Findings in 120 Malawian Children with Cerebral Malaria: New Insights into an Ancient Disease. American Society of Neuroradiology, published April 19, 2012 as 10.3174ajnr.A3035.
2. M.J. Potchen, S. Kampondeni, G. L Birbeck; C.A Hammond, A. Gonani, K.S. Phiri, K.B Seydel; T.E Taylor. Magnetic Resonance Imaging in Malawi: Contributions to Clinical Care, Medical Education and Biomedical Research. Malawi Medical Journal, 23(2):62-66 June 2011.
3. Matthew T. Latourette, James E. Siebert, Robert J. Barto Jr., Kenneth L. Marable, Anthony Muyepa, Colleen A. Hammond, Michael J. Potchen, Samuel D. Kampondeni, and Terrie E. Taylor. Magnetic Resonance Imaging Research in Sub-Saharan Africa: Challenges and Satellite-Based Networking Implementation. Journal of Digital Imaging, Vol 24, No 4 (August), 2011: pp 729-738.

More News You Don't Want to Miss

GE Healthcare was the sole provider of MR imaging during the 2012 Summer Olympic Games in London: page 74. See inside the body of an Olympic athlete, courtesy of GE MR, at **tiny.cc/spa1217**, and check out the GE MR Olympics ad named "Ad of the Day" in *Adweek*: **tiny.cc/spa1218**.



The "hot topic" of **multi-modality imaging** for accurate, personalized cancer care: page 56.



To read additional stories about advanced MR in India, please see pages 36 and 63.

SPACE-SAVING HIGH-FIELD MR TURNS VISION INTO A REALITY

Shimamoto Neurosurgical Clinic is a 19-bed hospital located in Onojo City, in the center of Fukuoka Prefecture. Hotetsu Shimamoto, MD, PhD, President/CEO and Medical Director, established the hospital with his namesake in 2001. "I thought it was necessary to establish a hospital that specializes in neurosurgery where local patients can visit without hesitation," he recalls.

Hotetsu Shimamoto, MD, PhD
is President and CEO of Shimamoto Neurosurgical Clinic.

Upon establishing the hospital, a 0.5T MR was installed. While at that time Dr. Shimamoto initially saw the need for 1.5T MR, the space for installation was limited. After some consideration, he realized that no 1.5T MR systems available at that time would fit within the space constraints of his facility.

In recent years, as the 0.5T system neared the end of its useful life, maintenance issues with the device increased, leaving him concerned that patients may be forced to frequently wait while the system issue was resolved. On the hospital's tenth anniversary, and in the midst of considering replacing the 0.5T MR, Dr. Shimamoto learned of the Brivo* MR355.

"Although Brivo MR355 is a 1.5T MR—a field strength that I believe is necessary to support the work we are doing—it is of a size that can be implemented in the same space where our 0.5T was installed. I remember how delighted I was to learn that," says Dr. Shimamoto. "With regard to the images, when compared with other products, the quality was completely different."

Some members of the staff were concerned about the cost of moving to a high-performance MR. "It was pointed out to me that the maintenance costs would be higher than our 0.5T system. However, news about the introduction of an advanced MR at our facility spread among patients by word of mouth and that resulted in an increase in new patients. Some visited to request a second opinion, while some wished to undergo a reliable evaluation prior to surgery. Currently, I feel that the merits of its introduction are greater than the maintenance costs."

Patient volumes continue to increase on a daily basis, not only from Onojo City, but also from neighboring cities, towns, and villages. Some patients even come from outside the prefecture—Oita Prefecture and Kagoshima Prefecture, for example. It is not uncommon to perform MR exams on more than 35 patients each day.

"Now our volume is approximately one-and-a-half times the number of exams prior to implementing the Brivo MR355. Even at this rate,

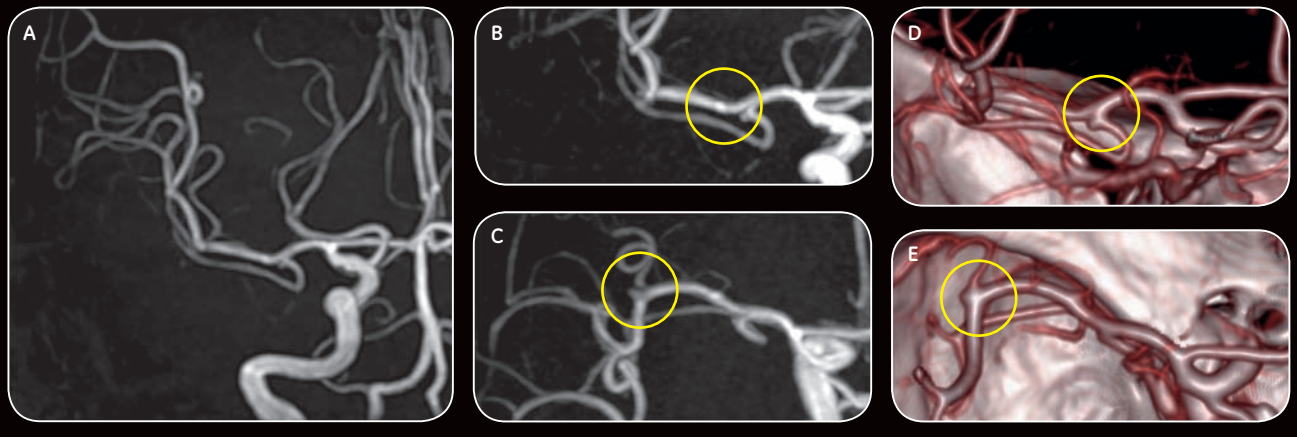


Figure 1. Patient with 1 mm aneurysm of the right arteria-cerebri-media domain; comparison images of a head MRA (B, C) and CTA (D, E). The flip horizontal of the CTA VR image is carried out for comparison with an MRA image.
MR parameters: FOV = 20 cm; slice thickness = 1.2 mm/-0.6 mm; matrix size = 288 × 192; imaging time = 4 min 54 sec.

exams have been continuously performed without any problems," says Dr. Shimamoto. "There is no concern about patient wait times and I really feel it was beneficial to have replaced our MR machine. The number of surgeries has also been increasing and, consequently, we are now performing them on multiple days rather than only on Wednesday afternoons."

Precise observation of morphology

With the Brivo MR355, Dr. Shimamoto notes that he can now more clearly see anatomy and morphology. "The images we are acquiring make us even more keenly aware of how good the quality is," he explains. "Aneurysms as small as approximately 1 mm that were impossible to see before are now being observed in clear focus; further, the morphology of brain tumors that was not noticeable before due to the lower image quality can now be precisely recognized.

"Brivo MR355 is equipped with the latest digital technology and due to the increased signal-to-noise ratio, our diagnostic ability has been greatly improved. With these images, I can diagnose more confidently than before," Dr. Shimamoto adds.

For example, recently, a patient who received an MR four years ago was re-scanned and an aneurysm was discovered. Although it was fortunate that the aneurysm did not lead to any serious problems, it was a life-threatening matter, he notes.

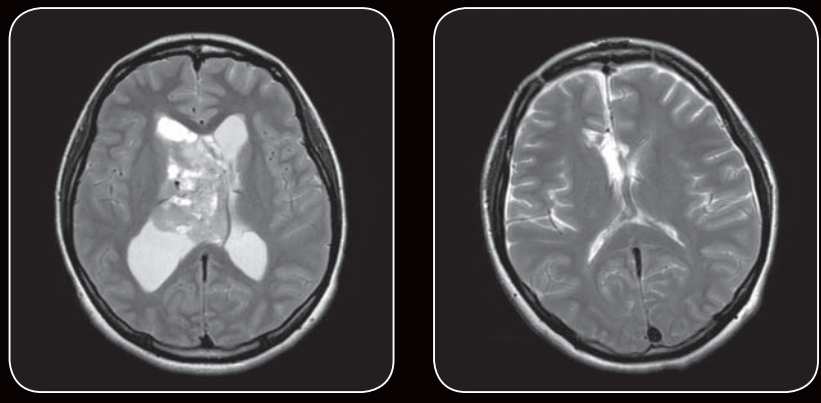


Figure 2. T2-weighted images pre- and post-central neurocytoma surgery (Axial images). MR parameters: FSE-XL FOV = 24 cm; slice thickness = 5 mm; slice intervals = 0 mm; matrix size = 384 × 256.

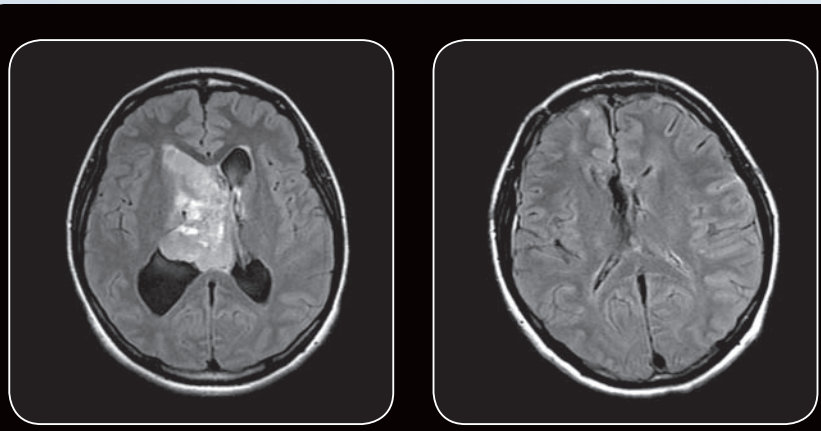


Figure 3. FLAIR images pre- and post-central neurocytoma surgery (Axial images). MR parameters: T2 FLAIR FOV = 24 cm; slice thickness = 5 mm; slice intervals = 0 mm; matrix size = 320 × 192.

Improved exam efficiency

The built-in Express coils that do not require replacement offer many advantages for technologists and patients. Patients can relax when undergoing an exam and the staff no longer has to replace the heavy coils.

"With shorter exam times on the new scanner, our efficiency has improved," explains Dr. Shimamoto. "Furthermore, the image-processing speed has also been outstandingly improved. The time it takes for the image to be sent from the MR room to the examination room is faster than the patient walking from the MR room to the examination room."

The enhancements to image processing time are the result of the system's new technology. For example, images are processed concurrently with the exam

on the built-in workstation console—an important feature of the Brivo MR355. This enables even emergency cases to be handled more promptly. Quick access to clear MR images provides powerful assistance to Dr. Shimamoto in making appropriate judgments and allowing him to handle surgeries as promptly as necessary.

The walls and ceilings of the MR room depict a blue sky.

A definitive diagnosis and improved patient experience

The walls and ceilings of the MR room at Shimamoto Neurosurgical Clinic are decorated with an image of a blue sky and are brightly illuminated using LEDs. The CT room is reflected by an image of the sea. Both rooms are decorated to help patients relax and be more comfortable during an imaging examination.

"The atmospheres of both the MR and CT rooms have received favorable reviews from our patients. We discovered the positive effect of reducing fear in patients prior to an MR or CT exam, especially when they are not familiar with the procedure. In particular, younger children appreciate it and are able to relax in order to undergo their exam."

In fact, after the introduction of the Brivo MR355, the clinic's CT system has been replaced with a new, space-saving and high-performance device from GE Healthcare.

"It is never acceptable for the diagnosis level to be low at local or small clinics. Rather, it is all the more necessary for the first clinic that a patient visits to maintain an environment in which a precise diagnosis can be made," Dr. Shimamoto says emphatically.

DIGITAL DIVE
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"The main purpose of medical treatment is to allow patients to get well and go home. The other day, a patient who was distressed about undergoing a tumorectomy at another hospital decided to undergo surgery after receiving an MR scan at our clinic. That patient got well and was discharged. I feel this demonstrates something good that comes from diagnostic imaging. In the future, I plan to work on evaluations of dementia patients with this MR, and as a community-based clinic, we will make precise diagnoses and provide appropriate treatment accordingly."

With the Brivo MR355, Dr. Shimamoto is well poised to realize this vision to deliver his ideal medical care and address a variety of neurological diseases and injuries.

Staff of Shimamoto Neurosurgical Clinic.

SUCCESSFULLY ADDING DWI TO IMAGING FOR PROSTATE CANCER DIAGNOSIS AND STAGING

In oncologic MR imaging, diffusion weighted imaging (DWI) is becoming an important protocol for delivering a comprehensive exam that can lead to a confident diagnosis. At Dr. Jones & Partners Medical Imaging in Adelaide, South Australia, Kirsten Gormly, MD, has followed the increased use of DWI. "This is what we should be doing. The [majority of] large research departments are using DWI, and for the smaller hospitals and clinics, the literature indicates that we need to incorporate this into our protocols for prostate imaging."

Dr. Gormly and her peers had been using high-resolution T2 imaging for diagnosis and staging of prostate

Kirsten Gormly, MB, BS, FRANZCR
works with Dr. Jones & Partners in Adelaide and is clinic director of their rooms at the Tennyson Centre, a private oncology day hospital.

cancers. "We knew we were missing some T3 extensions and not seeing all the tumors. Adding DWI would add to our diagnostic confidence."

Even though the sequence was on the center's newly installed Optima* MR450w, she wanted a better understanding of DWI and the physics behind it before implementing it. So Dr. Gormly set out to better understand its use in rectal, prostate, and pelvic oncologic imaging. She enhanced her knowledge of the sequence at the 2012 ISMRM meeting in Melbourne, and returned to Dr. Jones & Partners determined to add DWI to her oncology MRI protocols.

No time penalty, greater confidence

Tim King, Lead MRI Technologist, and Nigel Martin, Site Coordinator, at Dr. Jones & Partners worked with Dr. Gormly to implement GE's enhanced DWI (eDWI) technique. "With the Optima MR450w, we obtain higher SNR with the new optical RF technology, so we can reduce the time of the entire exam from our previous generation scanner and incorporate eDWI without any time penalty," King says. That was a key factor in convincing Dr. Gormly's peers to add the sequence to pelvic oncology exams.

With the color maps, Dr. Gormly instantly found that her eyes were drawn to key areas of interest. "ADC maps are quite grainy, so being able to overlay the maps on the T2 images helps draw my eyes to these areas, especially the anterior tumors," she says. "Even with the first case, my confidence increased."

Anterior gland tumors can be difficult to diagnose—often the patient has a negative biopsy even though their PSA level is high. Tumors demonstrate restricted diffusion on the ADC maps and overlaying that onto the T2 images helps Dr. Gormly identify the precise location. In one particular case (Figure 1)

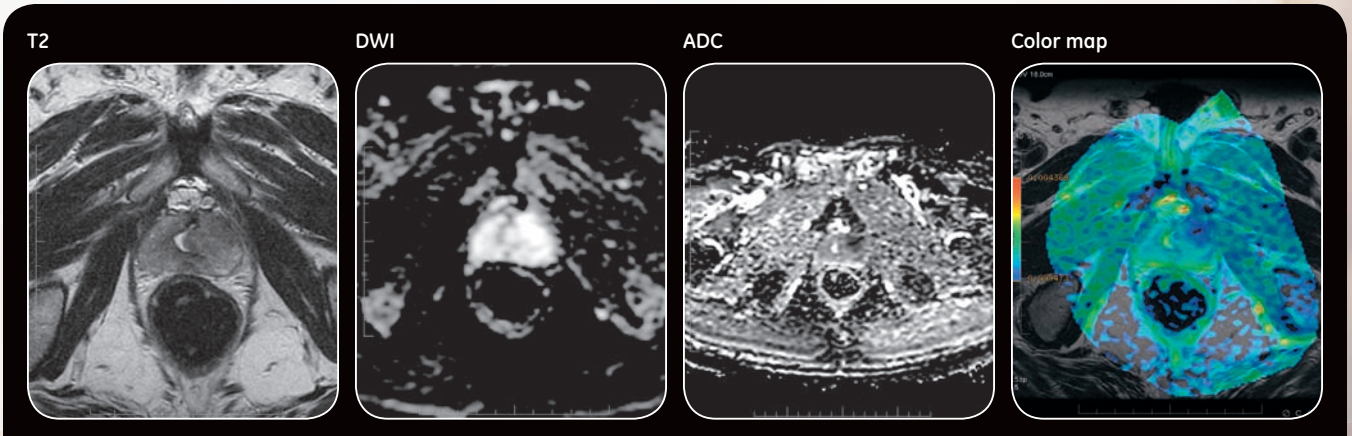

Figure 1. Patient history: PSA 11, Gleason 8 left apex. Previous TURP. Tumor sits in left anterior gland. T2 was difficult to interpret prospectively. DWI helped identify the tumor and gave confidence to call the T3 extension anterolaterally.

Prostate eDWI Protocol

The patient is positioned supine feet first with the 8-channel cardiac coil placed around the pelvis. The combined sequences protocol takes 22 min 52 secs.

Sequences

- T2 Axial whole pelvis
- T2 Sagittal high-resolution of the prostate
- T2 Axial high-resolution of the prostate
- T2 Coronal high-resolution of the prostate
- T1 Axial high-resolution of the prostate
- Diffusion (b-values 50, 400 and 800)

Following image acquisition, the data is transferred to the READY View work station. The color ADC map is then fused with the T2 axial high-resolution scan to assist with diagnosis.

Dr. Gormly could see the supportive features of a potential tumor on a T2 image, but had much greater confidence in calling the tumor by adding eDWI.

Fusing the ADC with the T2 image is not only useful, but easy and quick to perform using the READY View application that resides on the Advantage Workstation, adds King. "A simple click and drag of the datasets and we can fuse the images together. The workstation has a wide range of tools that go from simple MR reformats to diffusion and spectroscopy. It simplifies the post processing of data sets."

"The image fusion takes approximately two minutes to work up, and often within five minutes after completion it is available to the radiologists. It does not delay or interrupt our workflow," adds Dr. Gormly.

Finding the right b-value

Perhaps the most challenging yet important aspect of the eDWI implementation at Dr. Jones & Partners was determining the best b-values. "The normal high T2 signal in the prostate needs to be suppressed at high b-levels. In the prostate, which has a natural high T2 signal, the ADC map is more useful than the b-image. This is a reversal of (what we've learned in) neuro imaging."

A course at ISMRM on diffusion helped her better understand the importance of b-values. "The main question often is how many b-values we should use, and how high we can go," she says. "At our center, we obtain three values and use all to create the ADC map.

King and Martin worked with Dr. Gormly to find the b-values that worked best in prostate imaging. "It was advised to try

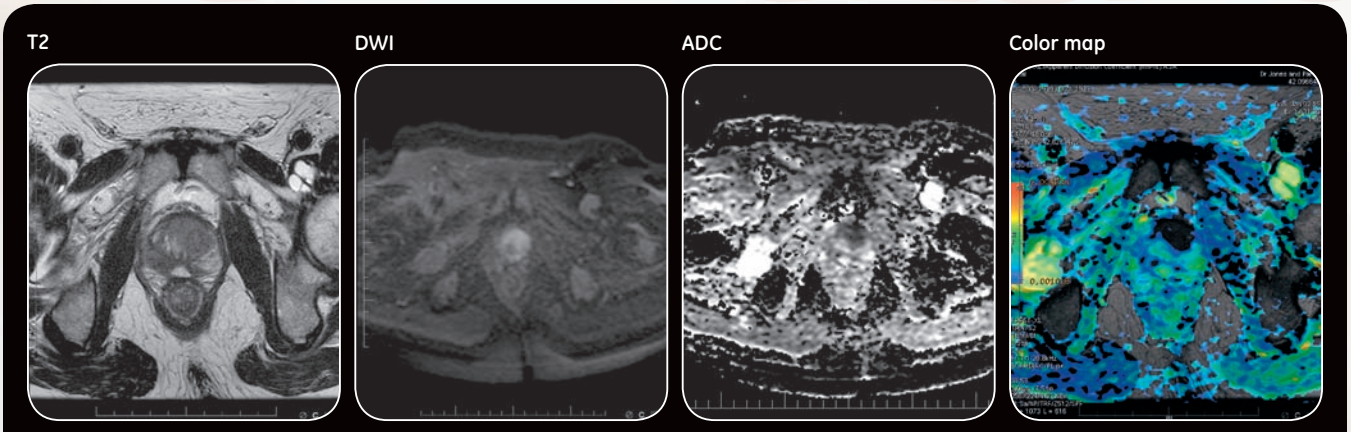

Figure 2. Patient history: PSA 15, Gleason 7 right apex and left mid gland biopsy. Several areas of abnormality noted. Peripheral zone complicated by post biopsy hemorrhage. Largest tumor nodule is located in the central gland, not seen on biopsy. With color map and ADC/DWI, tumor is well visualized with prominent restricted diffusion. Matching "erased charcoal" appearance seen on the T2.

Vitals...

According to Prostate Cancer Prevention, a Web site produced and maintained by the World Foundation of Urology-NEO, 680,000 men every year are diagnosed with a prostate tumor and 220,000 die as a result of prostate tumors.

out different high level b-values on our machine and see how high we could go while still maintaining enough signal," Dr. Gormly explains. "We found that at a b-value of 1,000, there was too much signal lost to define the prostate. With the 800 b-value we still had enough signal and could usually see the restricted diffusion on the DWI image." King and Dr. Gormly settled on b-values of 50, 400, and 800 for prostate imaging. "You have to get to know your machine and what will work," adds Dr. Gormly.

They then optimized the color maps on the workstation. "The ADC has to spread across the prostate region," notes King.

With the wide bore Optima MR450w, King finds the image quality is better as a result of less patient movement. "Patients are more comfortable and have less claustrophobia," he says. This allows him to focus on the patient and also conduct the exam more efficiently. On the previous 60 cm bore, King would get one or two patients each day that would decline the exam due to size or claustrophobia. In just the first six months of using the new wide bore system, only one patient declined the MR exam.

It's the patients who win most at Dr. Jones & Partners Medical Imaging. Better image quality, advanced imaging sequences such as eDWI, and a more comfortable patient experience are all key benefits. Finding more aggressive tumors, such as those with prominent restricted diffusion, has been made easier with the implementation of eDWI at Dr. Jones & Partners. And with an implementation that was "surprisingly easy," according to Dr. Gormly, more oncology centers will be able to offer their patients a comprehensive oncologic MR imaging exam that can help detect more tumors. S

Nigel Martin

Timothy King

Kirsten Gormly, MB, BS, FRANZCR, *works with Dr. Jones & Partners in Adelaide and is clinic director of their rooms at the Tennyson Centre, a private oncology day hospital. She trained in South Australia and spent two-and-a-half years in London, sub-specializing in oncology imaging and pelvic MR. Dr. Gormly trained under Dr. Gina Brown in rectal MR at the Royal Marsden Hospital. She regularly reports oncology CT and pelvic MR for prostate, rectal, and gynecological cancers as well as benign gynecological conditions. She participates in multidisciplinary meetings and is involved in audit and research related to pelvic MR. She is an invited speaker at many national meetings and helps run a national pelvic MR training course.*

Nigel Martin, *is the Site Coordinator for Dr. Jones & Partners and St. Andrews Hospital MRI Department. He received his Bachelor of Medical Radiation at the University of South Australia and earned a Graduate Certificate for Health Science from the University of Sydney. Martin oversees two GE scanners—a Signa* HDxt 3.0T, which is the only 3.0T private magnet in the state, and the newly installed Optima MR450w 1.5T.*

Timothy King *is the MRI Chief of Modality and Lead MRI Technologist at Dr. Jones & Partners. His education includes a Bachelor of Medical Radiations (Diagnostic Radiography) and Graduate Certificate in MRI.*

Dr. Jones & Partners Medical Imaging *is a sub specialized practice offering a comprehensive range of imaging service to the patients and referrers of South Australia. With a proud tradition of MR Imaging including the first MRI in the state, first private 3.0T magnet and a 1.5T Optima MR450w wide bore system, they are delighted with the clinical value enhanced Diffusion Weighted Imaging has added (eDWI) to our comprehensive MRI service offering.*

ENHANCING THE PATIENT EXPERIENCE

Singapore's Khoo Teck Puat Hospital implements GE Healthcare's 3.0T wide bore and 1.5T extremity scanners.

In the northern suburbs of Singapore lies a new hospital designed with patient comfort in mind. Since opening in June 2010, Khoo Teck Puat Hospital (KTPH) has won numerous awards for its green and energy efficient design. Patients can experience comfortable accommodations in different wards with views of greenery and naturally cool air from improved ventilation, and relax in the lush gardens and healing environment of the adjacent Yishun Pond.

KTPH is also the foundation for a vision to integrate healthcare in the northern region, providing high-quality, affordable healthcare to a community of more than 700,000 people. Part of that vision is to provide patient-centered, high-quality imaging that caters to a wide variety of patients. KTPH recently implemented the wide bore Discovery* MR750w 3.0T and the Optima* MR430s 1.5T extremity scanner from GE Healthcare.

Professor Wilfred C.G. Peh, Senior Consultant and Head, Department of Diagnostic Radiology, KTPH, shares how the machines help increase the comfort level of the patients. "The wide bore of the Discovery MR750w allows larger-sized patients to be scanned comfortably. Similarly, the extremity-dedicated Optima MR430s enables claustrophobic patients to be scanned without their whole body inside the machine."

Currently at KTPH, the majority of cases performed on the Discovery MR750w are MSK (50%), followed by neuro (35%), and liver (15%). On the Optima MR430s, most patients are scanned for sports-related injuries—mainly knees (60%), followed by ankles (20%), and wrists (15%).

Advanced 3.0T imaging

Clinical research is one of the three key pillars that distinguish KTPH as a center of healthcare excellence. The team can now delve deeper into non-contrast MR angiography studies using the Discovery MR750w's two new non-contrast applications: 3D Arterial Spin Labeling (3D ASL), a non-contrast perfusion technique, and Inhance 3D DeltaFlow, a non-contrast enhanced MRA, multi-station peripheral angiography sequence.

Wilfred C.G. Peh, MD, MBBS, MHSc, DMRD, FRCP, FRCR,
is Senior Consultant and Head, Department of Diagnostic Radiology at Khoo Teck Puat Hospital.

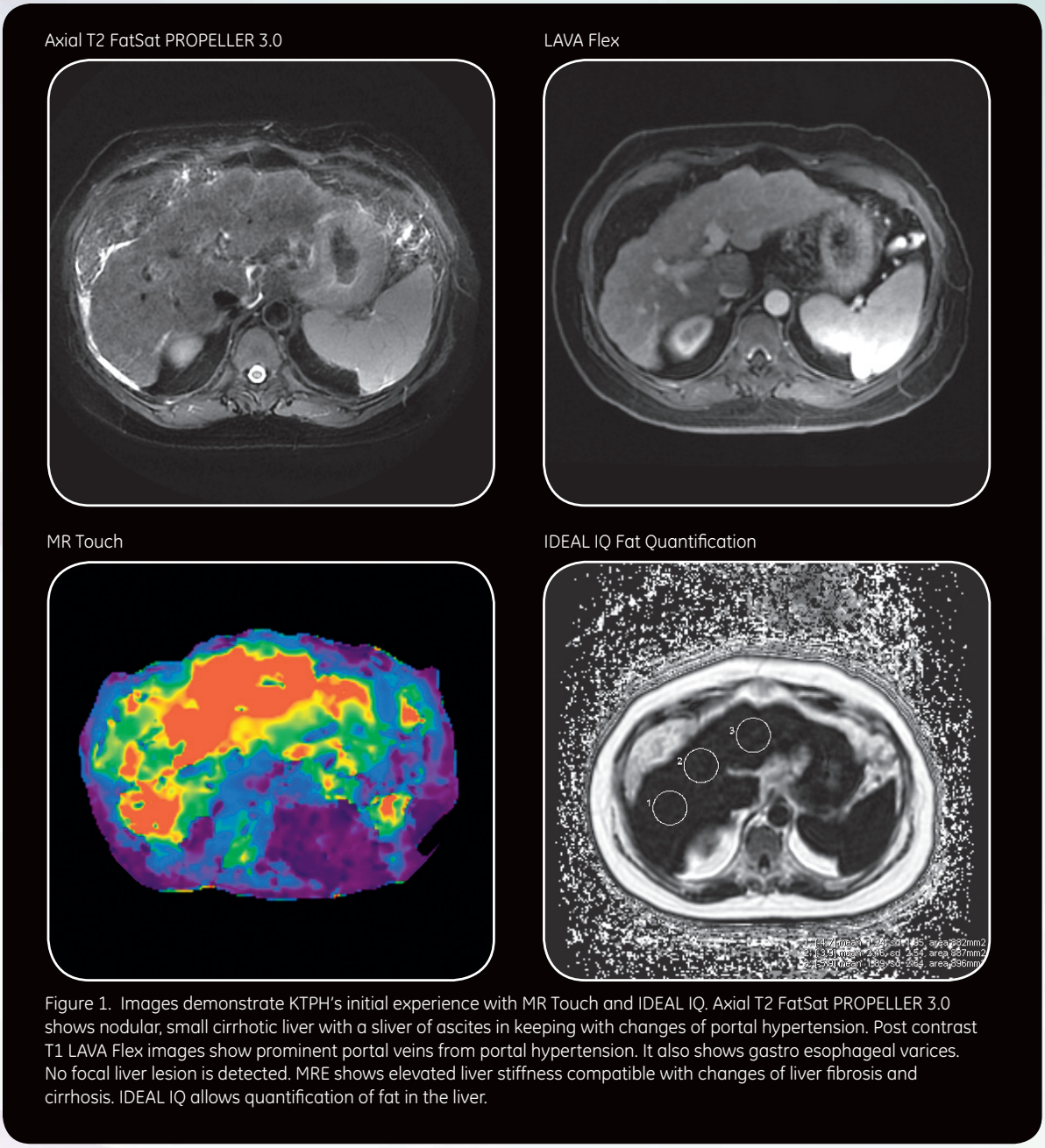

Figure 1. Images demonstrate KTPH's initial experience with MR Touch and IDEAL IQ. Axial T2 FatSat PROPELLER 3.0 shows nodular, small cirrhotic liver with a sliver of ascites in keeping with changes of portal hypertension. Post contrast T1 LAVA Flex images show prominent portal veins from portal hypertension. It also shows gastro esophageal varices. No focal liver lesion is detected. MRE shows elevated liver stiffness compatible with changes of liver fibrosis and cirrhosis. IDEAL IQ allows quantification of fat in the liver.

The incidence of peripheral vascular disease has increased over the past couple of decades. The Diagnostic Radiology team at KTPH is looking into other non-invasive imaging modalities to help in treatment planning and has recently initiated a study to investigate the use of Inhance DeltaFlow MRA versus catheter angiography for Peripheral Artery Occlusive Disease. Concurrently, the MR technologists' team has also embarked on a project using 3D ASL to quantify cerebral blood flow for the evaluation of reversible acute ischemic stroke versus irreversible brain infarction. Professor Peh sees tremendous potential in such clinical applications to provide new MR imaging opportunities to patients with renal insufficiency.

Another clinical application, MR Touch, offers a new diagnostic tool that identifies variations in liver tissue stiffness. For patients with chronic liver disease, it provides an alternative to invasive biopsy for detection of the presence of hepatic fibrosis, which can be treated if diagnosed before it progresses to irreversible cirrhosis.

A GEM of a coil suite

In addition to the high-quality images obtained on the wide bore system, Michael Chin Sze Min, Senior MR Technologist, is impressed with the Geometry Embracing Method (GEM) Suite of coils available on GE's wide bore MR systems. "We can obtain high-quality imaging without compromising scan

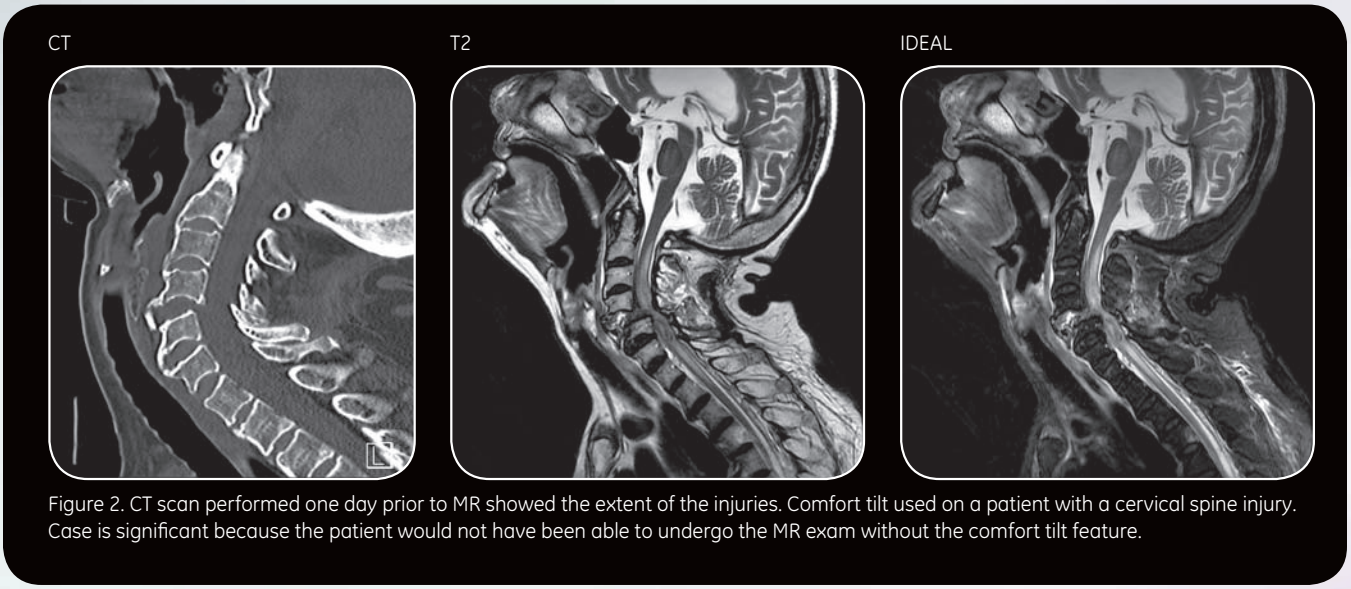

Figure 2. CT scan performed one day prior to MR showed the extent of the injuries. Comfort tilt used on a patient with a cervical spine injury. Case is significant because the patient would not have been able to undergo the MR exam without the comfort tilt feature.

time," says Michael, "particularly with the ability to perform parallel imaging in all three planes. Moreover, the standard 205 cm scan range available allows for whole body examinations with full usage of the surface coils, without the need for patient repositioning."

Furthermore, IntelliTouch patient positioning streamlines technologist workflow by allowing the technologist to center the scans faster without using a laser light system, adds Michael. "This saves time and hence affects the throughput of the system." Plus, the Autocoil function allows the correct coils to be selected only when needed to scan that particular region, he explains.

And, with the lightweight and flexible GEM coils, technologists can more easily carry and position them on patients.

Additionally, with the GEM comfort tilt head coil, kyphotic patients no longer need to lie completely flat on the table for head and neck scans. This results in a more comfortable scan for patients, helping them keep still during scans. Michael cites a recent case where the patient could not lie down flat for an MR cervical spine study on the wide bore 3.0T scanner. "It was found during the scan that the patient actually had a fracture-dislocation of the cervical spine," Michael explains. "She was immediately placed on spinal nursing after the scan with a C-collar put in place."

Patient comfort is high on the list of benefits afforded by the Discovery MR750w. The feet first imaging capability available for all examinations, especially for head imaging, means patients who are slightly claustrophobic can now be scanned as their level of anxiety is markedly reduced. Plus, the detachable table simplifies scan preparation as hospital inpatients are fully prepared outside of the scan room. This is particularly useful as there are reduced patient table transfers required for inpatients, or trauma or sedated patients.

"The whole package and design of this system makes it more patient and technologist centric," adds Michael.

> "The wide bore of the Discovery MR750w allows larger-sized patients to be scanned comfortably. Similarly, the extremity-dedicated Optima MR430s enables claustrophobic patients to be scanned without their whole body inside the machine."
>
> *Professor Wilfred C.G. Peh*

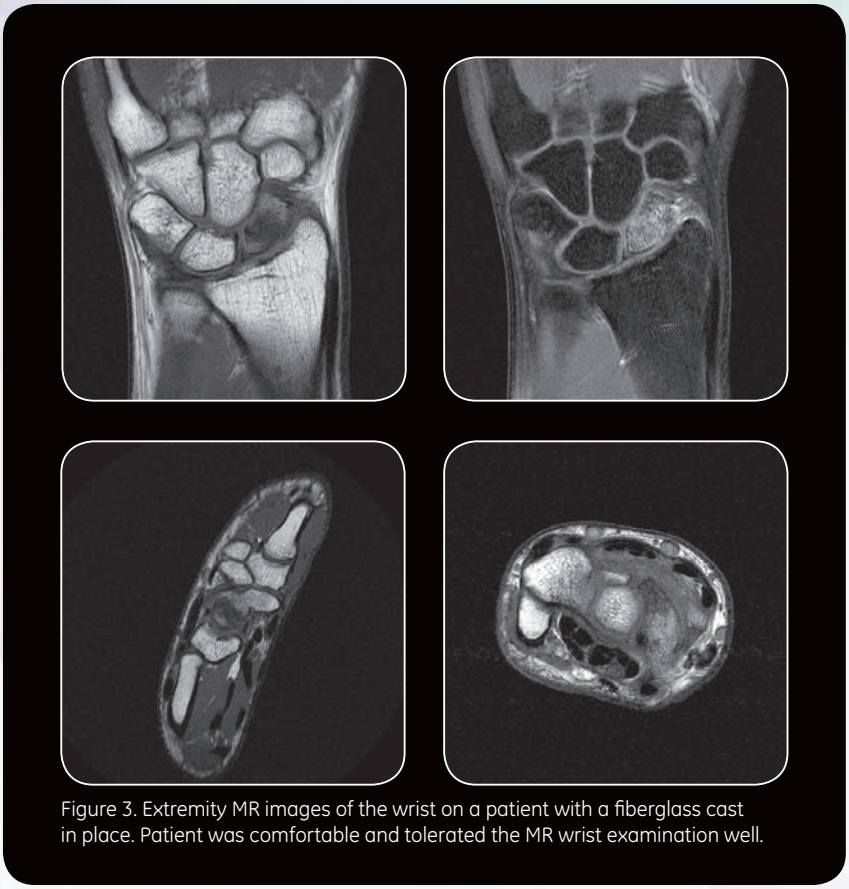

Figure 3. Extremity MR images of the wrist on a patient with a fiberglass cast in place. Patient was comfortable and tolerated the MR wrist examination well.

Small yet mighty

Because space within a healthcare institution is often at a premium, as with KTPH, the small footprint and high-quality imaging of the Optima MR430s allows the hospital to perform high-field scans and alleviate workload from the whole body scanner. The Optima MR430s is a leap forward in MR imaging because only the targeted anatomy needs to be inside the system while the patient sits comfortably in a chair next to the scanner. Unlike previous specialty systems, the Optima MR430s features a powerful 1.5T magnet. So, while patients experience greater comfort, radiologists get the image quality they need. For Professor Peh, the system is particularly useful to image patients with extremity sports injuries.

"Patients generally feel less frightened by the size of the machine," he explains. "Therefore, they are less claustrophobic and feel more comfortable during the scans." In fact, a patient recently insisted on having an extremity scan performed at KTPH as he experienced severe claustrophobia on a whole body MR system.

The patient experience

For Professor Peh and the radiologists at KTPH, it's all about delivering high-quality MR imaging while enhancing the patient experience.

The design of KTPH harmoniously brings together the elements of accessibility, comfort, and convenience, explains Professor Peh. By combining medical expertise with high-quality MR imaging and an exceptional standard of personalized care, KTPH strives to provide care that is truly good enough for the clinicians' own loved ones.

Michael Sze Min Chin

Wilfred C.G. Peh, MD, MBBS, MHSc, DMRD, FRCP, FRCR, *is Senior Consultant and Head, Department of Diagnostic Radiology at Khoo Teck Puat Hospital and Clinical Professor at the Yong Loo Lin School of Medicine, National University of Singapore. Professor Peh was past Editor of the Singapore Medical Journal and his Editorial Board memberships include Radiology, American Journal of Roentgenology, British Journal of Radiology, Skeletal Radiology, Seminars in Musculoskeletal Radiology, and American Journal of Orthopedics. Professor Peh has been Chief Examiner for the Master of Medicine (Diagnostic Radiology) at NUS for the last 11 years and has examined in Indonesia, Malaysia, Hong Kong, Sri Lanka and Belgium. He was the Founding President of the Asian Musculoskeletal Society and has held numerous Visiting Professorships.*

Michael Sze Min Chin *is the Senior Technologist in charge of the Magnetic Resonance Imaging (MRI) section in the Department of Diagnostic Radiology at Khoo Teck Puat Hospital. With eight years of experience in the field, Michael has advanced training in a wide variety of exam modalities, including X-ray and CT. His passion for physics, medicine, and computer technology led him to the field of MR, which he has specialized in exclusively since 2006.*

Khoo Teck Puat Hospital (KTPH) *is a 550-bed general and acute care hospital, managed by Alexandra Health. Opened in June 2010, KTPH offers a comprehensive range of medical services and specialist care to the community in the north. By combining medical expertise with high standards of personalized care, set within a healing environment, KTPH strives to provide high-quality care that is truly good enough for clinicians' own loved ones. KTPH is the first step in Alexandra Health's plan to build an integrated healthcare hub north of Singapore.*

RECENT ADVANCES IN CLINICAL MR OF ARTICULAR CARTILAGE

By Atsuya Watanabe, MD, PhD, Director, Advanced Diagnostic Imaging Center and Associate Professor, Department of Orthopedic Surgery, Teikyo University Chiba Medical Center, Japan

MR is a useful and non-invasive tool to evaluate articular cartilage. With the continued implementation of 3.0T MR for clinical use and improvement of the RF coil and pulse sequence, a high signal-to-noise ratio has been achieved to facilitate the acquisition of high-spatial resolution images. In addition, the clinical application of new MR techniques, capable of detecting changes in the biochemical components of articular cartilage at a high sensitivity, have been progressing and are expected to be useful for the early diagnosis of cartilage degeneration.

Morphological evaluation of articular cartilage

Various pulse sequences are used for MR evaluation of articular cartilage. The most common acquisition method is fat-suppressed, proton density weighted imaging using a 2D fast spin echo (FSE) sequence.

Proton density weighted imaging is intermediate between T1- and T2-weighted imaging. Relatively high contrast can be obtained between the cartilage and joint fluid and also between the cartilage and subchondral bone, providing useful information for the evaluation of articular cartilage. Using fat suppression, joint fluid is visualized as a strong, high-intensity region while normal cancellous bone is visualized as a low-intensity region. This facilitates the sensitive detection of joint fluid in injured cartilage and the ability to detect fluid present between a delaminated osteochondral fragment and the bone marrow.

When using a relatively short bandwidth or large pixel size in the acquisition, the image of bone marrow fat overlaps the image of cartilage due to a chemical shift artifact, making cartilage evaluation difficult; however, overlapping of the bone marrow fat image can be inhibited using the fat suppression method. Since articular cartilage is thin and has a curved structure, making a diagnosis based on a single imaging plane may lead to overlooking a lesion or misidentifying an artifact as a lesion. It is necessary to confirm lesions in several imaging planes on evaluation using 2D acquisition.

To overcome these issues, a 3D acquisition is employed in which the volume of the entire articular cartilage is imaged and a specific cross-sectional plane is evaluated on a workstation using multi-planar reconstruction. Various pulse sequences have been used for 3D MR of articular cartilage, yet most of these employed anisotropic voxels, which often deteriorated the reformatted image from the original image and thus led to a non-diagnostic study. To address this situation, acquisitions using isotropic voxels have been attempted. The isotropic voxel imaging method currently used employs 3D gradient echo (GRE) sequences, such as balanced-steady-state free precession sequences.

The 3D Cube FSE sequence has recently been utilized at our institution for the evaluation of articular cartilage. The 3D Cube FSE method is capable of acquiring isotropic voxel T2-weighted or proton density weighted images using FSE. Generally there have been problems with a 3D FSE method, such as blurring artifacts produced with T2 decay or the effective TE prolongs when the echo train length is increased to shorten the acquisition time. Using the 3D Cube FSE sequence, images with high-spatial resolution and favorable contrast of soft tissue—

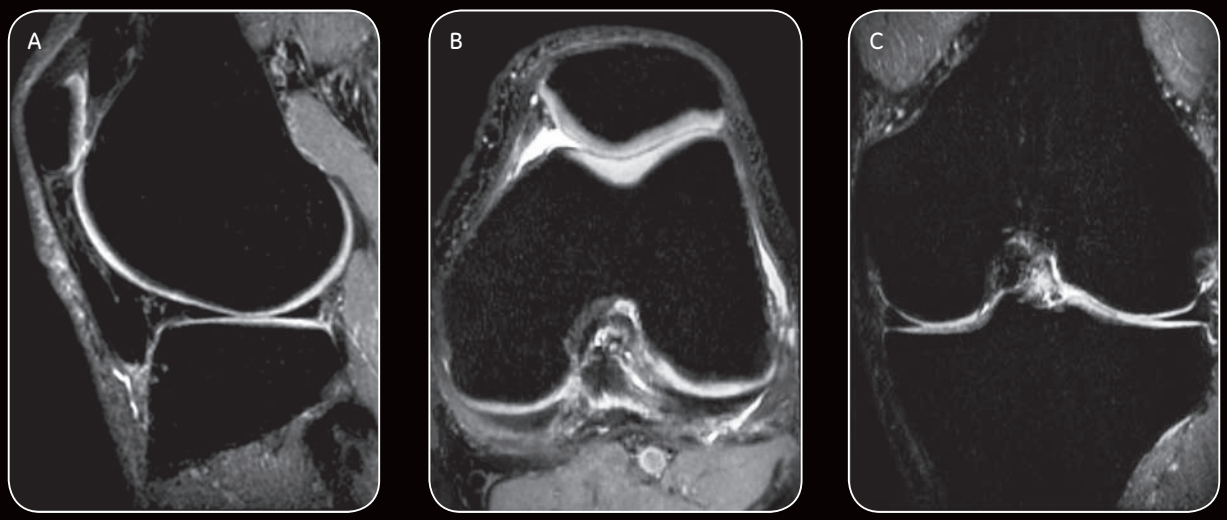

Figure 1. 3D isotropic MR images of the knee joint using the 3D Cube FSE method (0.7 x 0.7 x 0.7 mm). Sagittal plane, original image (A); transverse plane, reformat (B); coronal plane, reformat (C).

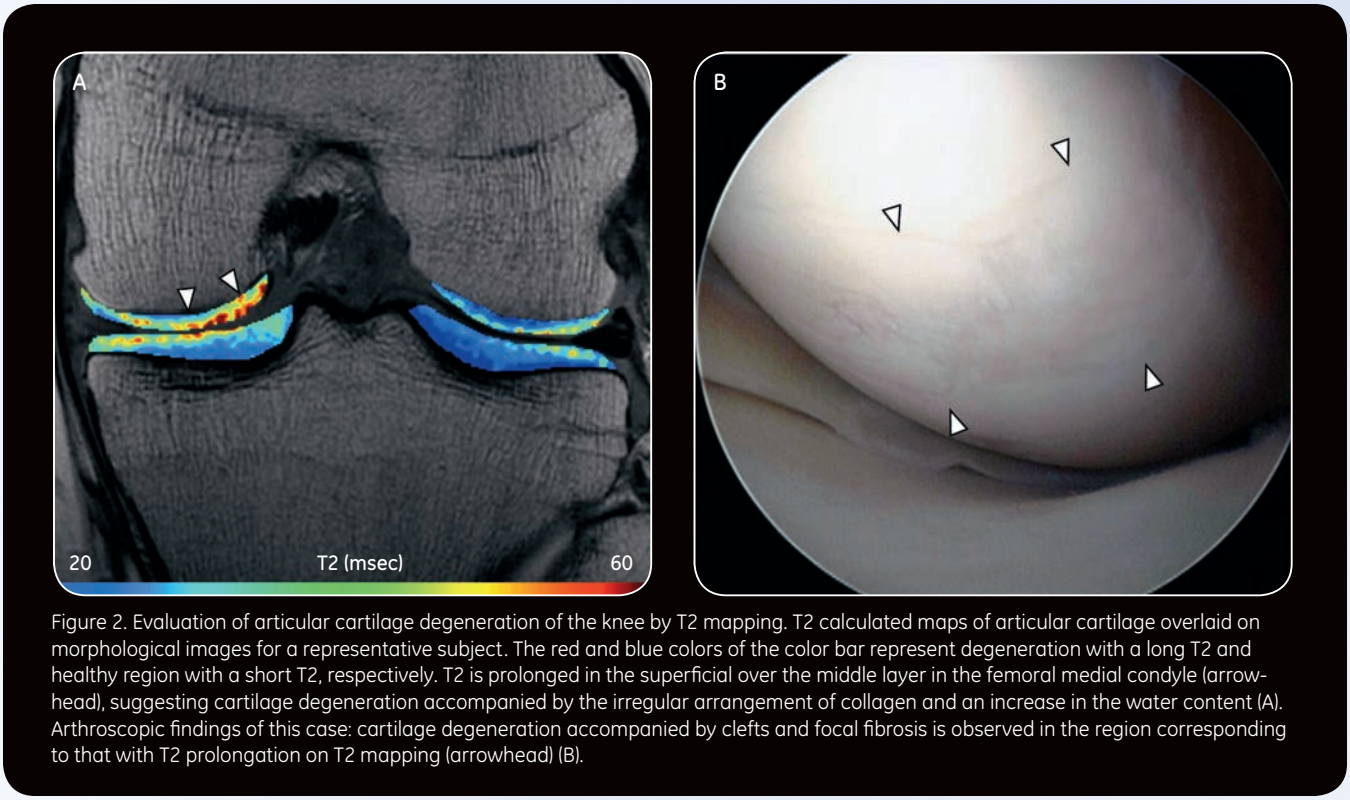

Figure 2. Evaluation of articular cartilage degeneration of the knee by T2 mapping. T2 calculated maps of articular cartilage overlaid on morphological images for a representative subject. The red and blue colors of the color bar represent degeneration with a long T2 and healthy region with a short T2, respectively. T2 is prolonged in the superficial over the middle layer in the femoral medial condyle (arrowhead), suggesting cartilage degeneration accompanied by the irregular arrangement of collagen and an increase in the water content (A). Arthroscopic findings of this case: cartilage degeneration accompanied by clefts and focal fibrosis is observed in the region corresponding to that with T2 prolongation on T2 mapping (arrowhead) (B).

inhibiting blurring artifacts—can be acquired, even when a long echo train is used, by changing the flip angle (FA) of the refocus pulse (termed refocused flip angle modulation).[1] In addition, the use of low FAs became possible, enabling the reduction of specific absorption rate (SAR).

It has been reported that the high contrast-to-noise ratio of articular cartilage and joint fluid can be obtained using the 3D Cube FSE method compared to five other new 3D MR methods for evaluating knee cartilage at 3.0T,[2] while maintaining sensitivity, specificity, and accuracy equivalent to the conventional proton density weighted imaging.[3] This suggests that the 3D Cube FSE method is very useful for the evaluation of articular cartilage.

In our examination of the technique, we added proton density weighted imaging using the 3D Cube FSE method to the conventional 2D acquisition as a routine protocol for the knee joint. Using a Discovery* MR750 3.0T and an 8-channel phased-array knee coil, our 3D Cube FSE parameters are: TR, 2200 ms; TE, 24 ms; FOV, 150 x 150 mm; section thickness, 0.7 mm; matrix, 224 x 224.

The advantages of isotropic voxel imaging are the high spatial resolution, and possibly more importantly, the capability of reformatting the original image to a specific cross-sectional plane—such as sagittal, coronal, transverse, and oblique coronal sections, without deterioration (Figure 1). This is particularly useful for the evaluation of relatively small lesions in articular cartilage that have a thin, complex spatial structure. When Time Course evaluation is performed using common 2D imaging, the target region is not necessarily included in the slice in all examinations, making evaluation difficult. In 3D isotropic voxel imaging, the target region can always be evaluated in the identical cross-sectional plane by 3D collection of the entire articular cartilage, which is useful for Time Course evaluation.

Atsuya Watanabe, MD, PhD

Director of Advanced Diagnostic Imaging Center and an Associate Professor, Department of Orthopaedic Surgery, at Teikyo University Chiba Medical Center.

Qualitative evaluation of articular cartilage

Articular cartilage abundantly contains a polar molecule, proteoglycan (PG), in a fine collagen fiber network. PG maintains a high swelling pressure of cartilage through interaction with water—another polar molecule—whereas the collagen fiber network maintains the cartilage morphology by resisting the swelling pressure. Articular cartilage is tolerant to mechanical loads due to this characteristic composition and structure, yet it has a poor healing ability as it lacks blood vessels and has low cell density. Degeneration of articular cartilage induces osteoarthritis (OA). Since no effective treatment is available for progressed OA other than surgery, it is desirable to diagnose articular cartilage degeneration as early as possible to initiate treatment that can prevent progression. In OA, cartilage degeneration accompanied by reduction of the PG content, irregular collagen arrangement, and an increase in the water content is observed from an early stage.

General routine MR is relatively sensitive in detecting morphological abnormality of articular cartilage, but it has been difficult to evaluate cartilage degeneration that occurs in an early stage of OA before the appearance of morphological abnormalities. New MR imaging techniques capable of the quantitative evaluation of changes in the composition and structure of cartilage, such as T2 mapping, have recently been clinically applied and are proving to be a useful qualitative evaluation method.

T2 mapping is an MR technique capable of evaluating the collagen arrangement and water content in cartilage, and it is useful for the detection of early-stage cartilage degeneration and quantitative evaluation of the severity of cartilage degeneration.[4] Collagen is dense and regularly arranged, and the water content is mostly maintained at a constant level in normal cartilage; however, irregular arrangement and an increase in the water content of collagen progresses with cartilage degeneration. Since these changes prolong T2, T2 of cartilage prolongs with the progression of degeneration. In T2 mapping, T2-calculated images are prepared, and differences in the collagen arrangement and water content are quantified as differences in T2. T2-based color-coded images are visually evaluated in the clinical diagnosis and T2 measurement across a range of interest in a T2-calculated image is performed in detailed quantitative evaluation.

The Discovery MR750 is equipped with an application (CartiGram) for T2 mapping of articular cartilage and capable of preparing and analyzing color-coded T2 maps on a console or workstation. CartiGram employs the multi spin echo method optimized to reduce the influence of stimulated

echo, facilitating T2 measurement with little error. Using CartiGram, we acquired images of the knee joint on the GE Discovery MR750 using an 8-channel phased-array knee coil under the following conditions: TR, 1,800 ms; TE, 11.5-92 ms; FOV, 140 x 140 mm; section thickness, 3.0 mm; matrix, 384 x 384. The time required for T2 mapping varies depending on the necessary spatial resolution—approximately eight minutes was necessary for our high-resolution acquisition.

T2 mapping is useful for the early diagnosis and quantitative evaluation of cartilage degeneration, yet several points are important for an accurate evaluation. It has been known that the water content and arrangement of the collagen network structure in the cartilage, which may be reflected in T2, may change according to location in the joint as well as layer in the cartilage.[5] In addition to the variation of cartilage matrix composition in the joint, T2 of cartilage has been known to be sensitive to the relationship between the collagen network and orientation of the static magnetic field (B0) due to the orientation-dependent dipolar interaction.[6] This is particularly the case when collagen fibers are oriented 54.7° relative to B0, which is termed the magic angle, as T2 is markedly prolonged on measurement at this angle. To avoid interpreting T2 prolongation due to the variation of cartilage matrix composition in the joint or the angle formed by collagen fibers and static magnetic field as cartilage degeneration, it is important to understand the regional differences of T2 in a specific joint.

Conclusion

Using a newly introduced clinical MR technique as discussed above in combination with the standard, routine MR, diverse and detailed information can be non-invasively collected, such as morphological changes in cartilage, the severity of cartilage degeneration, and location, range, and depth of lesions including the surrounding tissue. The importance of detailed MR diagnosis of the knee joint may increase with the advancement of preventive medicine for OA and progression of regenerative medical care techniques for cartilage injury.

References

1. Busse RF, Hariharan H, Vu A, Brittain JH. Fast spin echo sequences with very long echo trains: design of variable refocusing flip angle schedules and generation of clinical T2 contrast. Magn Reson Med 55:1030–1037. 2006.
2. Chen CA, Kijowski R, Shapiro LM, et al. Cartilage morphology at 3.0T: assessment of three-dimensional magnetic resonance imaging techniques. J Magn Reson Imaging.32:173-83. 2010.
3. Kijowski R, Davis KW, Woods MA, et al. Knee joint: comprehensive assessment with 3D isotropic resolution fast spin-echo MR imaging—diagnostic performance compared with that of conventional MR imaging at 3.0T. Radiology. 252:486-95. 2009.
4. Nieminen MT, Rieppo J, Töyräs J, et al. T2 relaxation reveals spatial collagen architecture in articular cartilage: a comparative quantitative MRI and polarized light microscopic study. Magn Reson Med, 46: 487-493, 2001.
5. A. Watanabe, Boesch C, Siebenrock K, et al. T2 mapping of hip articular cartilage in healthy volunteers at 3.0T: Topographic variation. Journal of Magnetic Resonance Imaging, 26:165-171, 2007.
6. Bydder M, Rahal A, Fullerton GD, et al. The magic angle effect: a source of artifact, determinant of image contrast, and technique for imaging. J Magn Reson Imaging, 25: 290-300, 2007.

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Teikyo University Chiba Medical Center *is one of the leading university hospitals located in Chiba, Japan. The Advanced Diagnostic Imaging Center offers advanced diagnostics through the use of state-of-the-art imaging equipment.*

WIDE BORE FEELS 'OPEN' TO PATIENTS, HELPING SOS GROW EXAM VOLUMES

Syracuse Orthopedic Specialists (SOS), one of the largest orthopedic groups in upstate New York, provides an array of clinical services including MR imaging. For many years in the early 2000's, open MR was in high demand due to the appeal to patients who were either claustrophobic or large sized. However, many open MRs were low Tesla strength, which led to poor image quality.

"We had a 0.7 open MR from GE, and in 2003 it was the best we could find," says Jim Colone, RT (R) (MR), Director of Ancillary Services.

The practice also has an older, short bore GE 1.5T magnet. While the open magnet enjoyed acceptable patient tolerance and image quality, it was considerably slower than the 1.5T magnet, explains Warren Wulff, MD, orthopedic surgeon. "With such a high volume of patients to scan coming from our large practice this became problematic. The physicians were faced with possibly purchasing a third scanner but GE offered a better solution in the wide bore magnet."

Initially, Colone was hesitant if the Optima* MR450w 1.5T with GEM Suite of coils from GE was going to be wide enough for large and claustrophobic patients. However, after looking at the available wide bore systems with technologist Diana Musson, RT (MR), and actually getting inside the bore, they were comfortable that a 70 cm wide bore would work.

Selecting GE from the available wide bore solutions was a logical choice, Colone explains. With the traditional bore MR from GE, he "already knew GE. My service is outstanding and we have an excellent field service engineer. Plus GE's software was already established with us."

Colone and Musson also felt the system software and coil development were more advanced than other existing solutions, and they were impressed with several of the new GEM Suite coils. "GE had the least confining head and neck coil," Colone explains. "For a claustrophobic patient, to put a face mask on them, it seemed more of a problem." The embedded spine coil for kyphotic patients and the comfort tilt feature were also key factors in their decision.

"Those were all pluses, and patient comfort is really what it is all about, especially for nervous, claustrophobic patients," adds Colone. In fact, the system is so aesthetically pleasing that SOS built a suite around the scanner to compliment the way it looks.

A jump in patient volume

With the increased speed of a 1.5T wide bore magnet, SOS has seen patient volume jump by 33%. Part of this increase is attributed to the reduction in triaging patients.

Jim Colone RT (R, MR)
is the Director of Ancillary Services and Program Development for Syracuse Orthopedic Specialists.

"When we had the open magnet, we had to triage the patient based on body part. Our radiologists did not want us to scan wrists, shoulder, or hips in the open bore due to poor image quality," explains Colone. "We had one spine surgeon who would never plan a surgery based on the open MR images. Now with the 1.5T wide bore, that triage work has gone away because the image quality has increased so much. That was a big win for us."

While 95% of referrals come from within the practice, Colone sees opportunity to further increase study volume. A neurosurgeon who scrubs in with an SOS spine surgeon looked at images from the Optima MR450w and was amazed at the quality. "Now, he is referring patients to us, and since we also have neuro protocols we are hoping to get their brain studies. That's another huge win for us," says Colone.

SOS traditionally has had trouble with difficult studies, such as cervical spines, shoulders and imaging around metal implants. The practice experiences the highest degree of motion on patients whose shoulder is being imaged. PROPELLER 3.0 is used for each of these studies, says Colone, while IDEAL is an excellent solution for helping suppress metal artifacts. "IDEAL may be helpful in imaging around MR conditional implants," he explains. "Prior to this scanner, we did not try to image knee replacements due to artifacts."

Enhancing the patient experience

With the combination of the GEM Suite and the 70 cm bore, there is more flexibility when positioning a patient, notes Musson. Plus, exams can be done feet first, head first, prone, or even in the decubitus position. This, along with the other added features of being able to control the air flow and lights in the scanner, has been beneficial in increasing the patient's comfort level. "Overall I'm impressed most by the increased number of patients who have been able to complete their exams due to these extra features," she says.

Patients are simply just more comfortable, Musson adds, as there is more room in the wide bore than in their previous open bore. Several patients who would not have fit in the open MR had room to spare in the Optima MR450w.

"They love the added distance between their face and the top of the machine and that their arms are not squeezed together when they enter the scanner," says Musson. "In regards to patient positioning, it is much easier to place the anatomy of interest at isocenter, which allows for better image quality."

Colone explains that in an open MR, there is less clearance between the body and the bore compared to the wide bore. For large or claustrophobic patients, this only compounds positioning issues. "We scanned a lumbar patient over 500 lbs in the wide bore," he says. "We would never have been able to scan him in the open bore; the magnet would have touched his stomach."

Plus, SOS has the added benefit of shorter scan times with the wide bore. A contrast-enhanced spine study that typically took one hour on the open

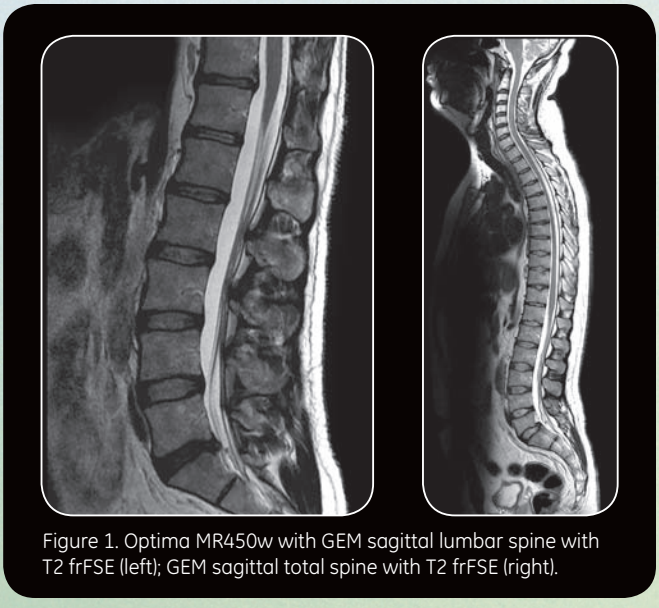


Figure 1. Optima MR450w with GEM sagittal lumbar spine with T2 frFSE (left); GEM sagittal total spine with T2 frFSE (right).

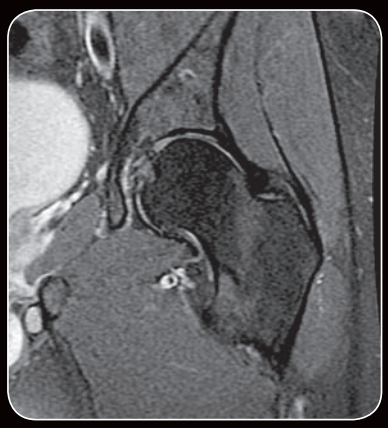


Figure 2. GEM coronal hip with off-center FOV and FatSat.

Figure 3. GEM sagittal knee with frFSE and FatSat.

bore is now completed in 25 minutes on the Optima MR450w. "When a patient is in pain, getting them out of the magnet quickly is a big plus," Colone adds. "We would spend one-and-a-half hours on a large lumbar patient in an open scanner only to have the surgeon be frustrated with the resulting image quality."

The undocking table also facilitates patient care. "GE was the only system that had an undocking table as a standard offering at that time, and we felt that was important for emergency patients," Colone says.

A scanner that suits all their needs

During the product evaluation period, a question was posed if SOS should consider a 3.0T scanner. Colone explains, "When our physicians and radiology group looked at the images, the answer was 'no,' there was no reason to spend the additional dollars. Some groups may need the highest strength MR scanner, but the image quality of the Optima MR450w went far beyond what we had experienced so far."

Dr. Wulff agrees, adding, "GE promised it would be as equally patient friendly as our previous open scanner while providing throughput and quality compatible with our closed 1.5T unit. One year after installation, the unit has performed as promised. I am particularly impressed with its ability to image obese patients. My imaging department has been very satisfied with patient tolerance, speed, and reliability, while our patients, technicians, and surgeons are all completely satisfied."

In fact, the practice is so impressed with the system that it has ordered a second Optima MR450w wide bore scanner with GEM Suite for installment at a new location.

Patients are noticing the difference as well between the open, traditional, and wide bore MR systems. Musson shares a recent experience with a claustrophobic patient who needed a lumbar MR. "He didn't realize he was claustrophobic until he had an MR on a closed magnet," she explains. "After barely making it through that exam, he decided to try the open MR at SOS the next time he needed a scan performed.

"He stated that it was better, but not really 'open,'" she says. "So the next exam we put him on the Optima MR450w. After his exam, he said that it was the most pleasant MR he had ever been in and he's not going to dread having an MR exam anymore."

Warren Wulff, MD

Diana Musson

Warren Wulff, MD, *is an orthopedic surgeon at SOS. He earned his undergraduate degree in Mechanical Engineering from Cornell University and went on to study medicine at the University of Vermont. Dr. Wulff then completed his fellowship training in spinal surgery at New England Baptist. He specializes in cervical and lumbar spine surgery as well as minimally invasive outpatient spine surgery.*

Jim Colone RT (R, MR) *is the Director of Ancillary Services and Program Development for Syracuse Orthopedic Specialists. Jim studied at Cortland State University and then went on to earn his degree in Radiologic Technology at Upstate Medical University in Syracuse, NY. He has several years of experience in patient care as an MR Technologist and currently oversees the Medical Imaging Department along with other service lines for SOS.*

Diana Musson *graduated from SUNY Upstate Medical University in 2004 with a Bachelor's degree in Medical Imaging. After college, she joined Syracuse Orthopedic Specialists and began her career as an MRI technologist. In 2010, she assumed a new role with SOS as Senior MRI Technologist.*

Syracuse Orthopedic Specialists, PC (SOS) is a group of specialty trained and focused orthopedic surgeons and mid-level providers committed to helping people lead active lives, treating sports and work-related injuries, detecting osteoporosis, replacing joints, and relieving chronic and acute pain. Our dedicated healthcare team provides customized care to patients at our eight conveniently located offices in and around the Syracuse area, including: Baldwinsville, Camillus, Cicero, Liverpool and Fayetteville along with our own Specialists One-Day Surgery Center. Our Surgeons also service two private hospitals in Syracuse: St. Joseph's Hospital Health Center and Crouse Hospital.

3D Cube in the MR Arthrography Exploration of the Elbow

By Dr. Philippe Tanji, MD, Musculoskeletal Radiologist,
Group Hospitalier Mutualiste Les Portes du Sud, Lyon-Vénissieux, France

Signa* HDxt 1.5T

Elbow radiography and ultrasonography are routinely indicated for the diagnosis of the lateral epicondylitis; however, in cases of untypical lateral epicondylar pain MR imaging is an often utilized exam. In these cases, MR arthrography is indicated to explore the different anatomical elements of the elbow's lateral compartment—evaluating the extent of disease and detecting associated pathologic processes.

The use of 3D Cube in our MR arthrography elbow protocol brings us an exhaustive analysis of the capsule, ligaments, and tendinous, plus intra-articular pathologies of the elbow—together reducing the number of sequences classically needed for this exam.

Patient history

A 49-year-old athletic patient presented with progressive epicondylalgia episodes. The patient had been diurnal and nocturnal for the last 12 months with a clinical examination showing pain under lateral epicondyle pressure in conjunction with reverse extension of a major finger. In addition, an observed painful reverse supination is in favor of a tendinous pathology. However, micro-traumas—due to intense sport practice and the advent of pain upon pressure on the humero-radial joint and extension of the elbow articulation—are suggesting a ligamentous or a condylo-radial joint involvement in the origin of the observed pain.

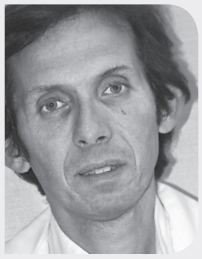
MR technique

The conventional approach of MR arthrography of the elbow with intra-articular gadolinium injection is to run the following sequences:

- A short, multiplanar sequence is performed for the best localization of the elbow joint;

MR Parameters	
Sequence:	3D Cube T2 Fast Spin Echo
Repetition time:	1740 ms
Echo time:	36.5 ms
Flip angle:	N/A
FOV:	18.5 cm x 14.8 cm
Matrix:	352 x 288
Slice thickness/ spacing:	0.7 mm
Number of slices:	178 (can vary with joint size)
Bandwidth:	41.7 kHz
Echo train length:	30
Total scan time:	5.57 min
NEX:	0.50
Imaging options:	Pre-Sat S,I,R, L/EDR
Fat suppression:	Yes, classic
Acquisition plane:	Oblique coronal
Reformat slice thickness:	1.1 mm
Reformat planes:	Oblique, sagittal and axial

Philippe Tanji, MD
is a radiologist at the private hospital Les Portes du Sud in Lyon-Vénissieux, France.



Additional parameters available at tiny.cc/spa1219

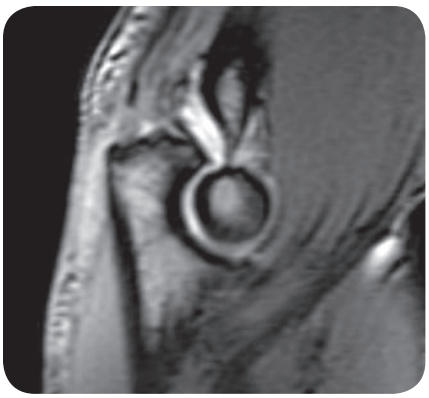


Figure 1A. Localization of the elbow joint is best accomplished by performing a short multiplanar sequence.

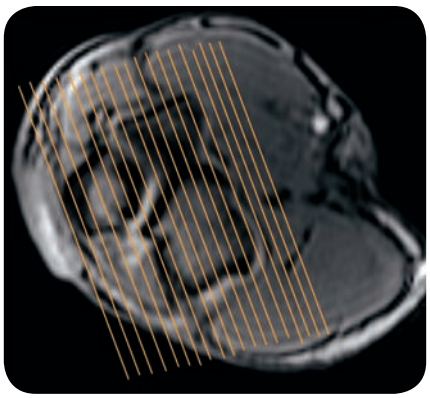


Figure 1B. The 3D Cube sequence is acquired in the coronal plane based on an axial image including both humeral epicondyles and oriented parallel to a line bisecting both epicondyles.

Figure 1C. Coronal localizer view.

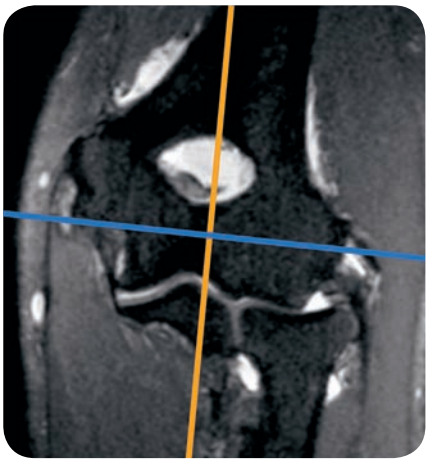


Figure 2A. Coronal 3D Cube T2 Fast Spin Echo weighted with FatSat, with multiplanar reformation capability in all standard orthogonal planes, were created from the volumetric source data immediately following the acquisition.

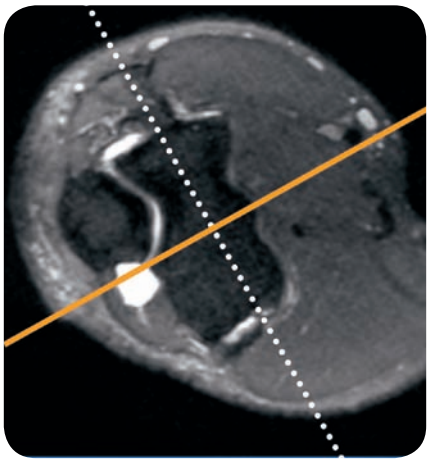


Figure 2B. Axial reformat plane is obtained perpendicular to the long axis of the humerus at the elbow on the coronal plane, to create blue crosshair in Figure 2A.

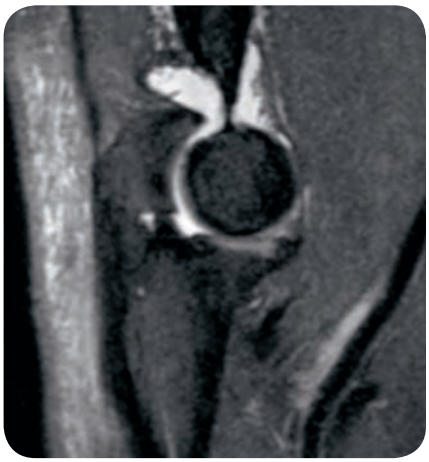


Figure 2C. Sagittal reformat plane is oriented perpendicular to a line drawn along the anterior surface of the condyles on the axial reformat plane, to create orange crosshair in Figure 2A.

- 2D FSE, T2/PD FatSat, 3 mm thickness, coronal or axial oblique, to depict subchondral bone marrow edema, inflammatory areas as well as tears and avulsions of the tendons;
- 2D FSE T1 FatSat in all three orthogonal-oblique planes to discriminate between inflammation from tears with gadolinium passing through the capsule ligament tendinous tears; and,
- 3D FIESTA, coronal oblique, T1/T2 contrast, 1 mm slices for the overlying cartilage of the different joints of the elbow.

On our 1.5T MR system (GE Signa* HDxt, release 15.0), for MR arthrography elbow exams, we position the patient's elbow into the HD T/R knee array coil, patient in "superman" prone position, with the affected arm over the head. This position keeps the elbow near the isocenter of the magnet, thus allowing a superior signal-to-noise ratio, more uniform fat suppression, and easier initial localization of the joint. This coil enables us to use parallel imaging (ARC) in order to decrease scan times and keep an overall reasonable examination time for the entire MR arthrography procedure.

The Cube protocol, with T2 weighting and FatSat, is acquired in the coronal plane in order to reduce the slice encoding volume—thus reducing the acquisition time (Figure 1).

This sub-millimeter and almost isotropic sequence provides a 0.7 mm contiguous slice thickness and enables one to either browse through the articulation right away during the scan procedure, or posteriorly reformat the volumetric source data and produce the expected orthogonal standard double oblique planes (Figure 2).

The Cube sequence, therefore, allowed us to rethink our classical approach of MR arthrography of the elbow. The Cube sequence now replaces the 2D FSE T2w oblique planes, and the double-oblique reformatted views replace two orthogonal 2D FSE T1w + FatSat sequences, thus significantly decreasing the total scan time, despite the somewhat longer scan time of the Cube sequence (5 min, 57 sec).

We now only utilize the FSE T1w + FatSat sequence with gadolinium to help differentiate inflammation versus tears in ligaments and tendons (Figure 5).

This 3D sequence allows exploration of the different joints of the elbow without having to force the patient's elbow position into the conventional flexion or extension positions in the magnet bore and coil. The sequence also makes additional 2D oblique scans unnecessary along specific planes, such as epicondylar and epitrochlear tendons and ligaments, as a function of the extension of the joint. The 3D sequence therefore offers the complete freedom for the radiologist to explore all anatomical structures of this joint.

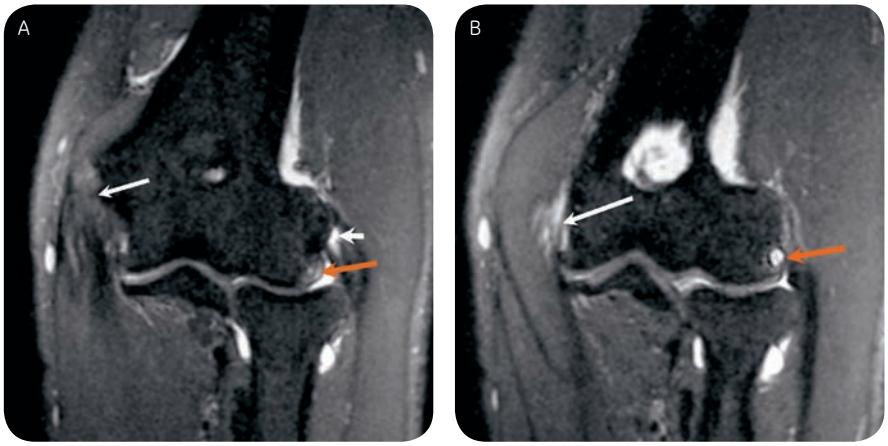


Figure 3. Coronal 3D Cube, T2-weighted Fast Spin Echo FatSat showing lateral epicondyle bone abnormalities in favor of cortico-periostal lesions, in similar conditions as conventional coronal 2D T2-weighted Fast Spin Echo sequence. The different reformat planes are showing a hypersignal fluid type that reaches the deep margin of the common section of the lateral and medial epicondylar tendons, in favor of a partial tear (white arrows).

Figure 3A. Typical edema of spongicus bone (orange arrow).

Figure 3B. Associated with a "geode" type hypersignal (orange arrow).

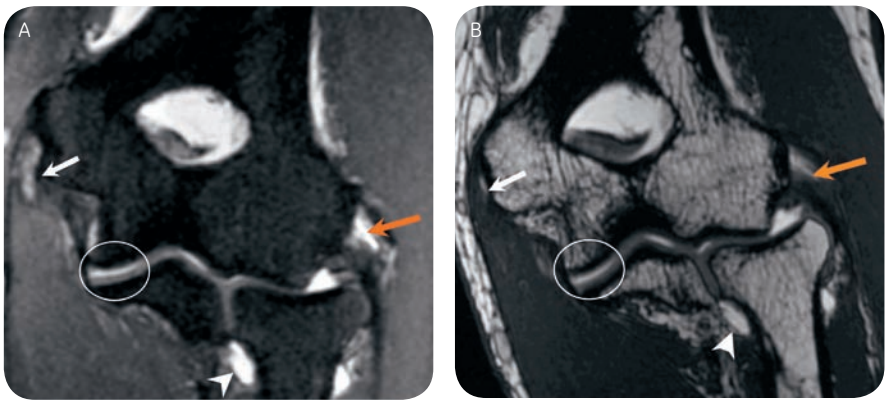


Figure 4. Submillimetric sequences: 3D Cube FSE in oblique coronal plane, performed after intra-articular injection of diluted gadolinium to dilate the articular cavity and the synovial recesses (arrowhead), ruling out focal chondral ulcerations or extended chondrolysis (white ring) in similar conditions as the 3D FIESTA sequence. The different coronal reformat planes are showing a hypersignal on the common extensor tendon of the lateral epicondyle (orange arrow) and the common flexor tendon of the medial epicondyle (white arrow) in favor of partial tears of those tendons.

Figure 4A. Coronal 3D Cube T2-weighted Fast Spin Echo FatSat MR image.

Figure 4B. Coronal 3D FIESTA gradient Echo T1/T2 weighted MR image.

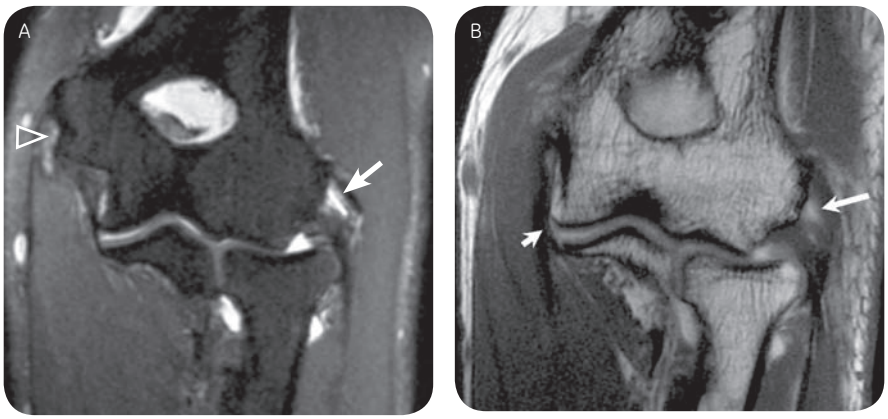


Figure 5. Several lateral and medial epicondylitis.

Figure 5A. Coronal 3D Cube T2-weighted Fast Spin Echo FatSat show an increased signal intensity of the deep fibers of the common extensor tendon (white arrow) and a slight signal of the common flexor tendon (arrowhead).

Figure 5B. Coronal 2D T1-weighted Fast Spin Echo depicts the high signal intensity of gadolinium fluid intra-articular and throughout the insertional fibers of the common extensor tendon (long white arrow), in relation with a partial tear of the radial collateral ligament and the common extensor tendon. There is no high signal of gadolinium within the common flexor tendon of the medial epicondyle in relation to an intact ulnar collateral ligament (short white arrow).

MR findings

The Cube sequence is now systematically used as part of our MR arthrography protocol in our institution. It enabled a significant decrease in the exam procedure time—over two minutes less per exam. The sequence allows a comprehensive exploration, especially in situations of post-dislocation instability, of the joint when a surgical procedure is planned—as well as with atypical epicondylitis where an articular pathology is suspected (such as capsule to ligament associated with tendinosis).

This sequence offers excellent spatial resolution with sub-millimeter (0.7 mm) slice thickness and 1.0 mm thick reformations, enabling an overlying cartilage analysis of the same quality as the millimetric 3D FIESTA sequence. However, it has the additional advantage of showing an intermediate cartilage signal that better differentiates its margin versus intra-articular fluid (Figure 4).

Cube T2w shows a diagnostic quality equivalent to the conventional Spin Echo or Fast Spin Echo T2w technique without any loss of information about the subchondral bone marrow edema and the ligamentous and tendinous tears (Figure 3).

Discussion

With this sequence plus the reformat post-processing, we can visualize the tendinous and ligamentous structures along their long axes in oblique coronal plane—without the constraint of positioning the patient's elbow in a specific extension or flexion standard positions. In addition, Cube demonstrated it can replace additional 2D oblique scans performed along the ligaments' longitudinal planes.

Philippe Tanji, MD, *is a radiologist at the private hospital Les Portes du Sud in Lyon-Vénissieux, France. Dr. Tanji has specialized in musculoskeletal imaging and interventional radiology since 1997. He started his initial fellowship in neuroradiology and then completed his radiology training in sports medicine imaging. He co-authored several articles and book chapters in the field of MSK. Dr. Tanji is now in his seventh year teaching radiology students at the Medical School of the University Claude Bernard Lyon 1.*

The Groupe Hospitalier Mutualiste Les Portes du Sud *is a new private practice clinic created in November 2008, resulting from the merging of two former institutions. Located in the south of Lyon, in France's second largest city, this center has a regional leadership in several medical specialties, built on quality and advanced clinical expertise.*

The Radiology Department is fully equipped with up-to-date imaging techniques, including a GE Signa HDxt 1.5T. The department performs nearly 9,000 MR exams each year, from which more than 72% are MSK. The MSK radiologists work closely with the clinic's orthopedic surgeons and sports medicine practitioners, as well as with other specialists in the Lyon area.

The Role of IDEAL IQ in Needle-Free Diagnosis of NAFLD

By Sunitha Reddy, MBBS, DNB, Director of Lucid Medical Diagnostics, India

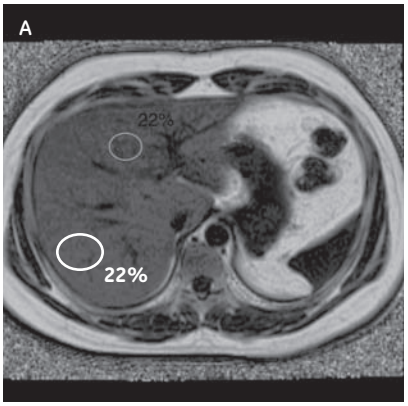
Signa* HDxt 1.5T

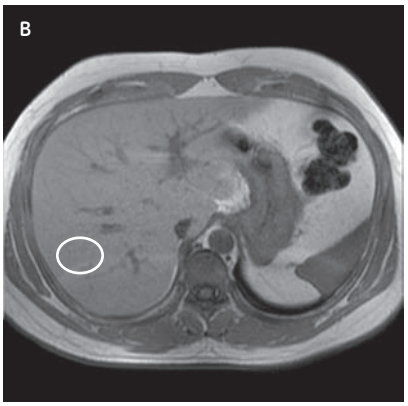
Chemical-shift MR imaging has been a non-invasive technique for the identification of tissues that contain a significant proportion of intracellular lipid. However, quantification of fat has not been possible—it could be achieved only by percutaneous liver biopsy, which is invasive. IDEAL IQ helps in quantifying the hepatic fat content, reducing the need for biopsy.

Patient history

A 38-year-old, non-alcoholic patient with fatty liver.

MR Parameters	
Patient position:	Supine, feet first
Sequence:	MFGR
TR:	175
ET:	8
TE:	2.9, 5.2, 7.5, 9.8, 12.1, 14.4, 16.7, and 19.0
Flip angle:	80 degree
Bandwidth:	62.5 KHz
Matrix:	256 x 192
Slice thickness:	8 mm
Slice spacing:	2 mm
Scan time:	15 sec in breath-hold





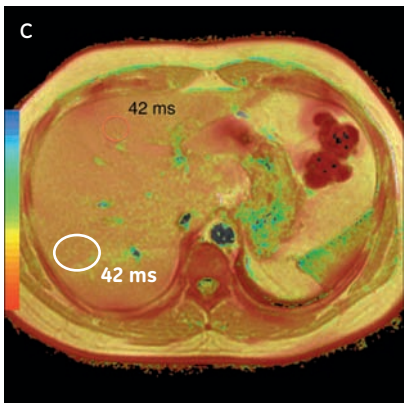


Figure 1. A 38-year-old patient with NAFLD. IDEAL IQ and T2* images show elevated triglyceride fat fraction, 22% (A), increased T2* (B), and R2* 42 ms (C).

Sunitha Reddy, MBBS, DNB,
is the Director of Lucid Medical Diagnostics.

MR findings

Axial Dual Echo sequence showed significant fatty infiltration of the liver. However, it could not be quantified and the severity of the disease also could not be assessed. IDEAL IQ and T2* of the liver showed elevated triglyceride fat fraction and increased R2*. Imaging findings correlated with the percutaneous biopsy and confirmed the diagnosis as non-alcoholic fatty liver disease (NAFLD).

Discussion

NAFLD is an emerging cause of chronic liver disease and can lead to cirrhosis, hepatocellular carcinoma, and liver failure. The prevalence is on par in the Indian population due to increasing socioeconomic status. It is paralleling the epidemics of diabetes and obesity. Liver biopsy is the current gold standard and can establish a definite diagnosis, determine the severity of the condition, and provide information about prognosis. However, it is invasive and associated with complications, and suffers from sampling variability. The lack of a safe, inexpensive, and non-invasive method for accurate identification and quantitative grading of NAFLD has been a major barrier to understanding its epidemiology and pathophysiology.

The IDEAL IQ imaging technique exploits the resonant frequency differences between fat and water measured as phase differences in multiple echoes. The use of IDEAL IQ improves the accuracy of tissue characterization parameters (R2 or fat) by removing contamination from multiple chemical components. It has the potential of becoming a rapid, accurate, and non-invasive test for the estimation of hepatic fat content without the need for performance of percutaneous liver biopsy.

Sunitha Reddy, MBBS, DNB, *is the Director of Lucid Medical Diagnostics in Hyderabad, India. She studied medicine at Gandhi Medical College and DNB Radiodiagnosis at Apollo Hospital. She worked on the first 3.0T MR in South East Asiaen. Dr. Reddy has published 10 papers in national and international journals, and she has written a book on Gastrointestinal Imaging. Her specialized areas of imaging include epilepsy, temporal bone, orbit, skull base, cardiac CT, breast, and abdomen.*

Lucid Medical Diagnostics *is a comprehensive health care facility established in 2007 for rendering state-of-the-art diagnostic facilties with a common goal of ushering in a revolution in health care delivery. Lucid has five centers spread across Andhra Pradesh and Karnataka. Cutting-edge technology is complimented by senior expert radiologists who have sub-speciality experience, enabling referring physicians/surgeons to arrive at the final diagnosis. Lucid's goal is to achieve diagnostic excellence with professional management, quality accreditations, innovation, and more importantly, the "We know, so we care" approach to healthcare. The use of IDEAL IQ on the Signa HDxt 1.5T is made possible by a research agreement between GE Healthcare and Lucid Medical Diagnostics.*

Signa* HDxt 3.0T

Evaluating White Matter Lesions with Spectroscopy

By Carlos Martinot Luyo, MD, Medical Director, CEREMA SAC and Professor of Neurology, San Marcos University, and Julio D. Saldana, MD, Radiologist, CEREMA SAC, Peru

Introduction

MR spectroscopy provides a measure of metabolic information that is complementary to conventional MR imaging. Common clinical applications include evaluation of brain tumors, infectious and neurological diseases, cerebral ischemia and infarction, and neurological diseases.

In some cases, it is nearly impossible to differentiate tuberculomas from primary brain neoplasms or Multiple Sclerosis (MS) from other white matter lesions based on imaging findings alone. Studies conducted in our facility have found citrulline to be a useful tool in the diagnosis of MS; this metabolite was found in a greater proportion of patients with MS than in the normal population. Similarly, the changes in brain metabolites between brain tuberculomas and intra-axial neoplastic process may provide us an approach for diagnostic differentiation.

Carlos Martinot Luyo, MD,

is the Medical Director for CEREMA SAC and a Professor of Neurology at San Marcos University, Lima, Peru.

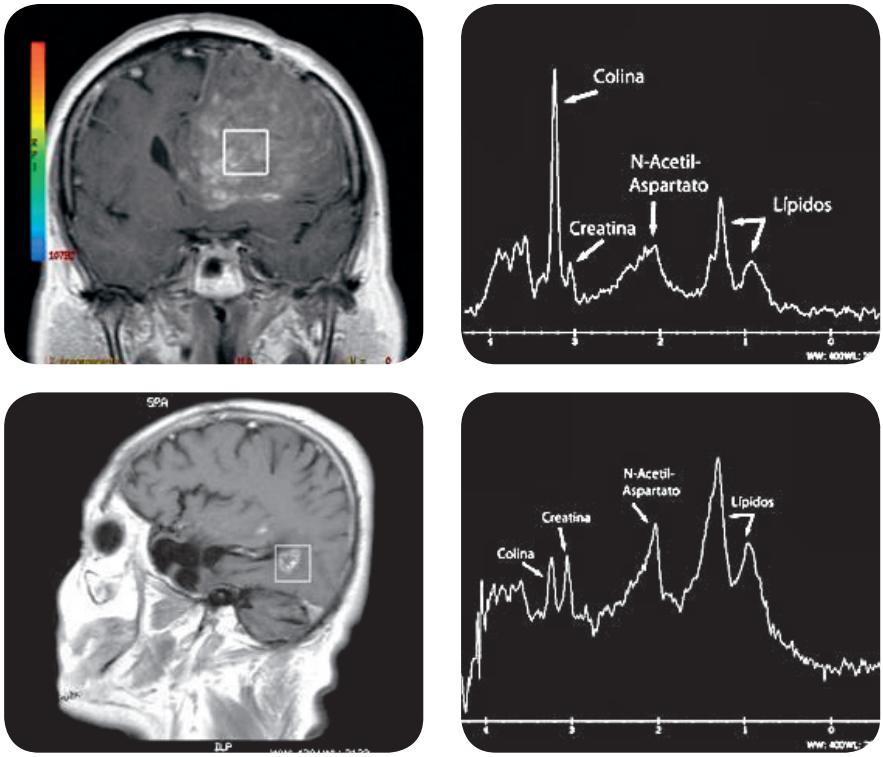


Figure 1. H+ MR spectroscopy used for the differential diagnosis between tuberculoma and intraaxial neoplastic process.

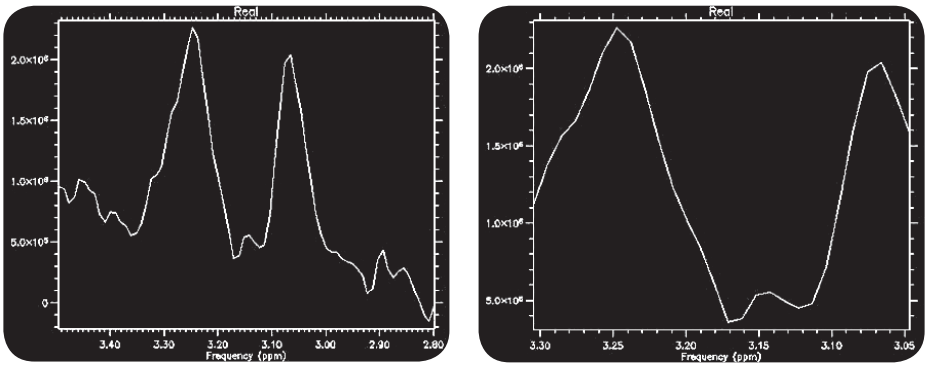


Figure 2. Evaluation of the utility of the metabolite citruline (3.15 ppm) detected with MR spectroscopy in the diagnosis of multiple sclerosis.

Patient histories

Patients with intracranial masses or white matter lesions with non-specific clinical and imaging findings were evaluated.

In our institution, we conducted two studies of patient groups using MR spectroscopy. In a study of brain tuberculomas and intra-axial neoplastic process, 24 patients between ages two and 72 years underwent the brain structural and spectroscopic study univoxel with a voxel of 20 mm x 20 mm x 20 mm (8 cc) located at the level of the lesion determined. Ratios were assessed Choline/Creatine, N-Acetil-Aspartato/Creatina and Mio-inositol/Creatina. All cases were confirmed via an anatomical-pathological or therapeutic test.

A second study of 16 patients with multiple sclerosis and 11 controls between the ages of 11 and 53 years with an average of 32 years were studied. We used brain voxel spectroscopy 15 mm x 15 mm located in the frontal lobes in chronic plaques or in contrast filmmaker plates. We looked for the presence of citrulline as well as obtained the respective ratio of citrulline/creatine spectroscopy using advanced SAGE (General Electric Advance Version Spectroscopy 7).

MR parameters

PRESS TE 35 ms single voxel.

Post processing with SAGE to find Citrulline in white matter lesions.

MR findings

We found that a Cho/Cre ratio >1.97 is statistically significant (p 0.017) for neoplasms and a Cho/Cre ratio <1.15 is statistically significant for tuberculomas.

Discussion

Several lesions show an increment of the Cho/Cre ratio. The importance of this study is the determination of specific values to enable accurate diagnoses of neoplasms versus tuberculomas. This is particularly helpful in Latin America and other third world countries were there is a large incidence of tuberculosis. However, tuberculomas are mimickers of other brain lesions. Now, appropriate treatment can be provided, greatly reducing the number of unnecessary brain biopsies.

Finding citrulline in white matter lesions is important to the accurate, early diagnosis of MS. These lesions are very non-specific and can be seen in a number of etiologies (vasculitis, migraines, microvascular ischemic changes, etc.) making it impossible to make a diagnosis of MS based on imaging findings alone. Unfortunately, the clinical symptoms are also often nonspecific, particularly early in the disease. Therefore, finding a metabolite that is specific to MS is a great contribution to early diagnosis. Early diagnosis and treatment is important to improving long-term outcomes for patients.

Magnetic resonance spectroscopy allows a more confident diagnosis of intraparenchymal brain lesions of uncertain etiology. S

Carlos Martinot Luyo, MD, *is the Medical Director for CEREMA SAC and a Professor of Neurology at San Marcos University, Lima, Peru. Dr. Luyo is a former Chief of Neurology at the Peruvian Air Force Hospital.*

CEREMA *is an imaging center dedicated exclusively to MR imaging since 1996. It is the Peruvian market leader in MR imaging and the first to introduce advanced MR techniques such as DWI, DTI, spectroscopy, and functional MRI to the country. The center currently has a Signa HDxt 3.0T, two Signa HDxt 1.5Ts, and a 0.5T Signa Contour, which is one of the few of its kind still operational worldwide.*

Non-invasive Liver Evaluation

By Shalini Thapar, DNB, MBBS, Assistant Professor,
Department of Radiodiagnosis at the Institute of Liver and Biliary Sciences, India

Signa* HDxt 3.0T

The portal venous hypertension, degree, and rate of progression of fibrosis are important prognostic factors in patients with chronic liver disease. The degree of fibrosis is currently assessed with liver biopsy, and several semi-quantitative pathologic scoring systems have been proposed. Portal venous pressures can be measured directly only by use of invasive techniques, such as direct portal venography or direct splenic puncture. Currently, the most widely accepted and used measurement method is an indirect but invasive one—hepatic vein wedge pressure measurement. However, this technique is impractical for serial monitoring or evaluating treatment response and is not widely used in specialty hepatology centers. Several factors point out the need for a non-invasive method to evaluate chronic liver disease.

MR technique

Patients are imaged in the supine position with a 19 cm diameter, 1.5 cm thick cylindric passive shear wave driver placed against the anterior abdominal wall. Continuous longitudinal vibrations at 60 Hz are generated by means of a variation of acoustic pressure transmitted from an active driver device through a vinyl tube (2.5 cm inner diameter, 7.6 m length).

MR Parameters	
Scan time:	38 sec
Patient position:	
Patient entry	Feet first
Patient position	Supine
Coil:	8US TORSOPA
Plane:	Axial
Series description:	MRE

Shalini Thapar, DNB, MBBS
is an Assistant Professor, Department of Radiodiagnosis at the Institute of Liver and Biliary Sciences.

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For more information:
tiny.cc/spa1207

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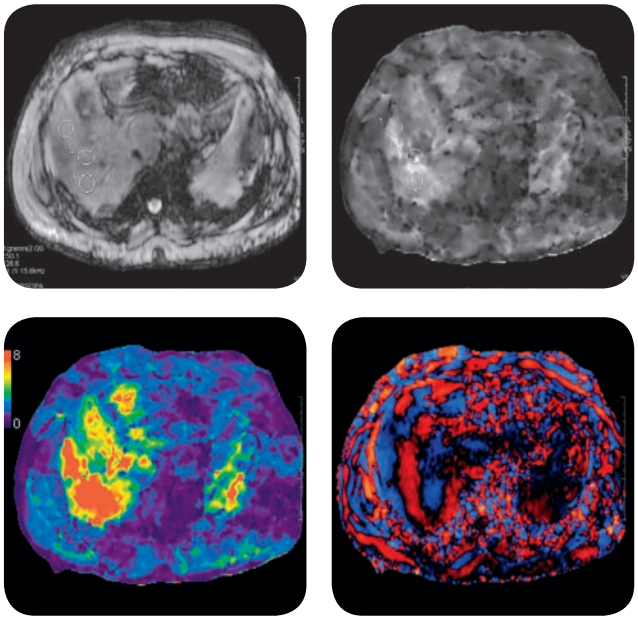
For more information:
tiny.cc/spa20

Case 1



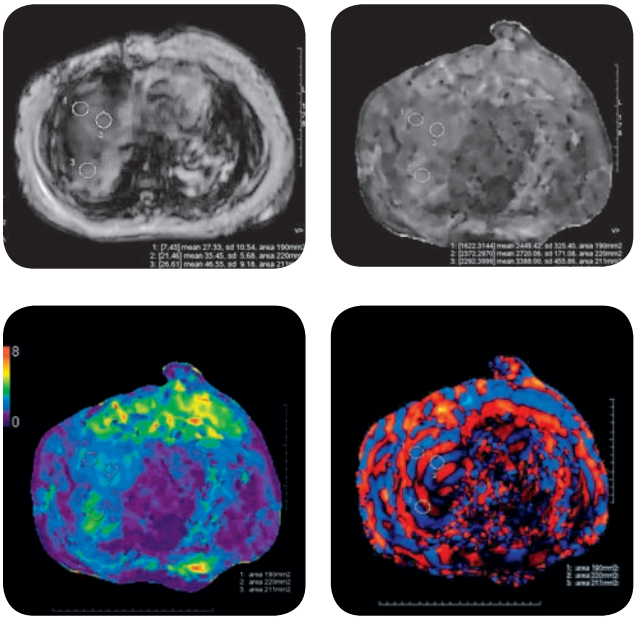
Patient history

A 51-year-old patient with cryptogenic chronic liver disease and portal hypertension, grade III esophageal varices, known bleeder.

MR findings

MRE showed an average value of 7.1 kPa indicating elevated tissue stiffness across the regions of interest shown above. The modified Ishak Biopsy Score was 6 confirming the presence of severe fibrosis. In addition, biopsy confirmed active hepatitis with steatohepatitis.

Case 2



Patient history

50-year-old patient, hepatitis B+.

MR findings

MR Elastography revealed an average value of 2.68 kPa signifying that the patient had no sign of elevated tissue stiffness globally; however mild, elevated stiffness is noted in segment 7 with a value of 3.4 kPa. This case demonstrates the utility of MRE for identifying focal regions of elevated tissue stiffness across the liver.

Discussion

In both cases presented, MRE provided regional tissue stiffness measurements across the liver that could be used in conjunction with biopsy or additional clinical methods for evaluating liver fibrosis. MRE was found useful in detecting both early and late stages of tissue stiffness in focal regions as well as providing a global evaluation of the entire organ. As a result, we feel MRE represents a valuable tool for identifying focal liver disease while providing a non-invasive technique for follow-up evaluations.

Shalini Thapar, DNB, MBBS, *is an Assistant Professor, Department of Radiodiagnosis at the Institute of Liver and Biliary Sciences, where she was responsible for setting up the department to include an array of advanced imaging equipment, including 3.0T MR and 64-slice CT. Dr. Thapar earned her medical degree for radiodiagnosis from Diwan Chand Satuyapal Aggarwal Imaging & Research Center, where she was awarded the Dr. Arcot Gajaraj Gold Medal by the National Board of Examinations for securing the highest marks in the final examination. Dr. Thapar has presented numerous scientific papers and posters, and has published several articles on CT and MR imaging.*

The Institute of Liver and Biliary Sciences (ILBS) *has been established by the Government of the National Capital Territory (NCT) of Delhi as an Autonomous Institute, under the Societies Registration Act – 1860, at New Delhi. ILBS has been given the status of Deemed University by the University Grants Commission (UGC). The mission of ILBS is to become a dedicated international center of excellence for diagnosis, management, and advanced training and research in the field of liver and biliary diseases.*

The Department of Radiodiagnosis at the Institute is equipped with a high-definition 3.0T MR, a spectral energy 64-slice CT, DR, CR, C-arm angiography unit, RFA machine, and other routine equipment. Radiological image viewing capabilities are available to all the concerned departments and wards through a fully integrated PACS and Hospital Information System. The use of MRE on the Signa HDxt 3.0T is made possible by a research agreement between GE Healthcare and ILBS.

Discovery* MR750

3.0T High-resolution Carotid Plaque MR

With 3.0T, 6-channel Carotid Coil and MR PlaqueView Analysis

By Kevin DeMarco, MD, Associate Professor, Director of Magnetic Resonance Imaging
Department of Radiology, Michigan State University, US

Carotid atherosclerosis may be responsible for as much as one-third[1] of all strokes. To better gauge risk of stroke from carotid atherosclerosis, clinicians are beginning to look beyond traditional risk factors such as carotid artery narrowing (stenosis) to identify high-risk features of the atherosclerotic plaque itself.[1, 2, 3] MR plaque characterization can play a key role identifying vulnerable plaques in these patients, especially those with transient ischemic attack or in the sub-acute stage.

Patient history

A 72–year-old with asymptomatic right carotid stenosis. The patient has a history of hyperlipidemia, hypertension, and tobacco use, and has a BMI of 30.2. The patient's hyperlipidemia is well controlled (LDL-C = 88 mg/dL) with statin use since 2005. Despite meeting current AHA cholesterol guidelines, the patient has a moderately sized deep necrotic core with hemorrhage involving the right carotid bifurcation. MR carotid plaque imaging scans were performed in 2010 and in 2011 as a follow up.

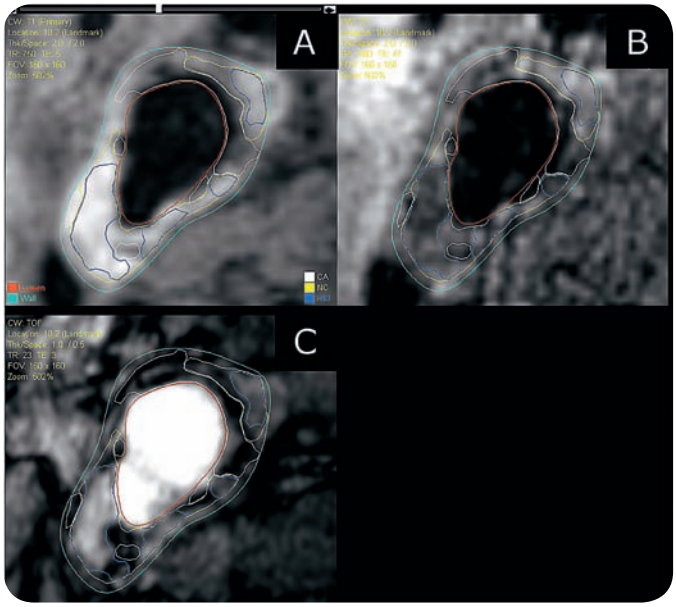


Figure 1. MRI-PlaqueView delineates plaque components such as calcium (white), necrotic core (yellow), and hemorrhage (blue). (A) T1w (B) T2w (C) TOF.

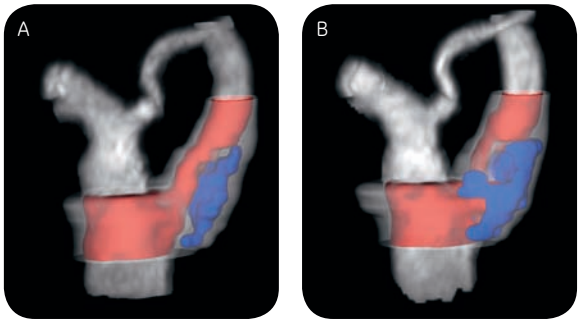


Figure 2. Hemorrhage area (blue) expanded from 2010 (A) to 2011 (B).

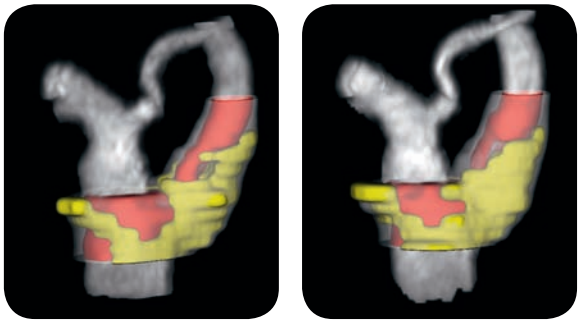


Figure 3. Necrotic core area increased.

Kevin DeMarco, MD

is an Associate Professor and Director of Magnetic Resonance Imaging, Department of Radiology, Michigan State University, East Lansing, MI.

MR Parameters

Sequence:	Non-contrast MRA 3D TOF	Black-blood T1w 2D DIR FSE	Black-blood T2w 2D FSE
Scan time:	4:46	7:00	6:18
TR:	23	750 (1RR)	1500 (2RR)
TE:	3.9	6	48
Flip:	20	N/A	N/A
BW:	31.2	41.7	41.7
ETL:	N/A	12	16
FOV:	16	16	16
Slice thickness:	2 mm/1 mm ol	2	2
Frequency:	288	256	256
Phase:	256	224	224
Freq dir:	L/R	L/R	L/R
Phase FOV:	1	1	1
NEX:	1	2	1
# RR:	N/A	1	2

MR technique

3D TOF MRA, T1w Black-blood DIR FSE, and T2w Black-blood DIR FSE were performed using a 6-channel carotid coil. 3D TOF was used for assessing degree of stenosis, while T1w and T2w imaging were used to differentiate plaque components.

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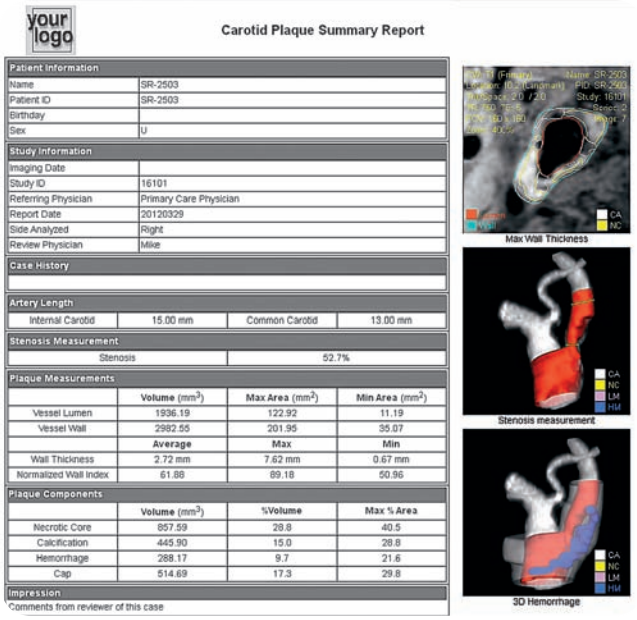
Click to view remaining parameters on-line.

MR findings

The total volume of necrotic core was estimated at 30.1% volume in 2010 with 9.3% volume of hemorrhage. In 2011, his moderately sized hemorrhage now extended from deep in the plaque to be juxtaluminal with a new rupture of his fibrous cap. The lumen of the right ICA went from a 50% diameter stenosis by NASCET criteria with irregular narrowing to a 58% stenosis and a new ulcer in 2011. There was a much smaller hemorrhagic necrotic core involving the left ICA (not shown) with no change in the percentage of stenosis (21% in 2010 and 24% in 2011).



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Carotid Plaque Summary Report

Patient Information	
Name	SR-2503
Patient ID	SR-2503
Birthday	
Sex	U

Study Information	
Imaging Date	
Study ID	16101
Referring Physician	Primary Care Physician
Report Date	20120329
Side Analyzed	Right
Review Physician	Mike

Case History

Artery Length			
Internal Carotid	15.00 mm	Common Carotid	13.00 mm

Stenosis Measurement	
Stenosis	52.7%

Plaque Measurements	Volume (mm^3)	Max Area (mm^2)	Min Area (mm^2)
Vessel Lumen	1936.19	122.92	11.19
Vessel Wall	2982.55	201.95	35.07
	Average	Max	Min
Wall Thickness	2.72 mm	7.62 mm	0.67 mm
Normalized Wall Index	61.86	89.18	50.96

Plaque Components	Volume (mm^3)	%Volume	Max % Area
Necrotic Core	857.59	28.8	40.5
Calcification	445.90	15.0	28.8
Hemorrhage	288.17	9.7	21.6
Cap	514.69	17.3	29.8

Impression
Comments from reviewer of this case

Figure 4.

3.0T Carotid Coil

A 6-channel array (3-channels per side) dedicated for high-resolution carotid imaging. It features a concentric design for deep tissue penetration and excellent SNR. ASSET is supported for accelerated imaging.

MRI-PlaqueView from VP Diagnostics

Provides visualization and quantitative analysis of multi-contrast carotid plaque MR data. Helps delineate vessel wall, calcifications and soft plaque.

Discussion

This case illustrates the potential for carotid plaque imaging to give the clinician additional information to stratify risk and help guide medical therapy. Despite very good therapeutic control of the patient's hyperlipidemia, there is evidence of ongoing carotid plaque disease with hemorrhagic necrotic core and an increase in the right carotid stenosis, as well as the development of a new ulceration. The additional information provided by 3.0T MR carotid plaque imaging could help identify patients with ongoing plaque pathology, despite adequate therapy by current standards that may benefit from new medical treatments.

References:

1. Altaf N, Daniels L, Morgan PS, et al. Detection of intraplaque hemorrhage by magnetic resonance imaging in symptomatic patients with mild to moderate carotid stenosis predicts recurrent neurological events. J Vasc Surg. 2008;47:337–42.
2. Takaya N, Yuan C, Chu B. Association between carotid plaque characteristics and subsequent ischemic cerebrovascular events: A prospective assessment with MRI—initial results; Stroke 2006; 37:818-23.
3. Singh N, Moody A R, Gladstone B J. Moderate Carotid Artery Stenosis: MR Imaging-Depicted Intraplaque Hemorrhage Predicts Risk of Cerebrovascular Ischemic Events in Asymptomatic Men. Radiology 2009; 252:502-8.

Kevin DeMarco, MD, *is an Associate Professor and Director of Magnetic Resonance Imaging, Department of Radiology, Michigan State University, East Lansing, MI. Dr. DeMarco received his medical degree from St. Louis University Medical School and completed his internship and residency at the Naval Hospital Oakland, Oakland, CA and a neuroradiology fellowship at the University of California, San Francisco, CA. At Michigan State University, Dr. DeMarco directs a non-invasive in vivo 3.0 T MR carotid plaque research program to evaluate patients referred to specialists for known carotid stenosis. He has authored numerous publications on carotid imaging and owns two patents; one on Methods and Apparatus for Defining a Three-Dimensional Imaging Section and the other on Apparatus and Method for Detecting and Classifying Atherosclerotic Plaque Hemorrhage.*

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The MSU Department of Radiology advances knowledge and transforms lives by providing expert patient-centered medical care, delivering exceptional pre-professional and professional medical education, and expanding the understanding of wellness and disease through research and community service.

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imagination at work

MAINTAINING RESOLUTION WHILE REDUCING BREATH-HOLD TIME WITH LAVA FLEX

When a technologist is scanning an ailing patient, reducing breath-hold time is the key to obtaining high-quality images due to breathing artifacts. For example, many sick patients may struggle to maintain a 20-second breath-hold, while a 12-second breath-hold is quite achievable. Fortunately, if the technologist is trained in scan optimization, the scan protocols can be altered to reduce scan time and have minimal impact on the quality of the resulting images.

LAVA Flex is one application where knowing how to change protocols to reduce breath-hold time can prove extremely valuable. Often used to image lesions in the liver, LAVA Flex is frequently used with patients who may struggle with extended breath-hold times. Michael Chin Sze Min, Senior MR Technologist at Khoo Teck Puat Hospital (KTPH) in Singapore, has been working to fine-tune his techniques to reduce breath-hold during a LAVA Flex scan with minimal impact on image quality. "By understanding how adjusting variables can affect scan time and scan integrity, it's possible to reduce breath-hold to about 12 seconds and still obtain high-quality images," says Michael.

Altering phase resolution

MR scan times can be long for two reasons: phase steps (resolution) and the number of slices the technologist is acquiring. Reducing the phase resolution or the number of slices should result in a shorter scan time. It is important to note that when a technologist changes scan protocols there is often a tradeoff. Therefore, the technologist needs to think about how an action will affect other aspects of the scan.

In liver studies, reducing the number of slices may not be an option because the technologist needs to obtain whole-organ coverage. Reducing phase resolution can result in a lower resolution image so small reductions are recommended. For example, in a LAVA Flex study, phase resolution can be dropped from 224 to 192 with little effect on resolution. Utilizing 320 x 192 and 4.4 mm slices will give adequate resolution and whole organ coverage with around 52 slices.

Changing user control variables (CVs)

Another way to reduce scan time and achieve a shorter breath-hold is to alter settings for the parallel imaging technique ARC (Autocalibrating Reconstruction for Cartesian imaging) during the scan. ARC allows phase and

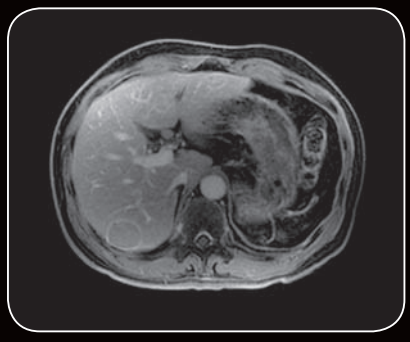


Figure 1A. Twelve second LAVA Flex acquisition demonstrating portal venous phase.

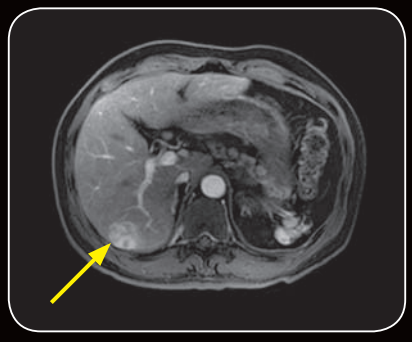


Figure 1B. Note enhancing lesion.

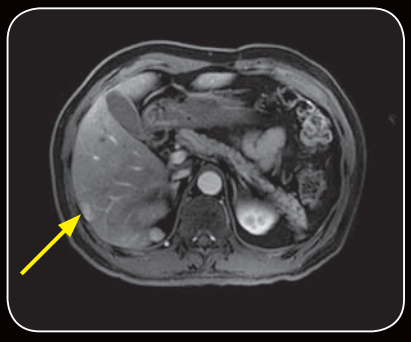


Figure 1C. Note enhancing lesion.

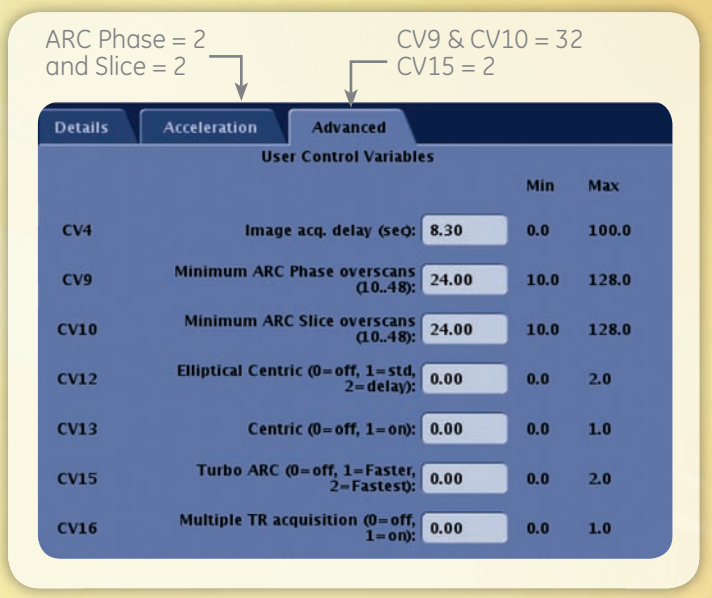


Figure 2.

slice acceleration simultaneously on 3D scans by synthesizing missing k-space data from neighboring data. By default, LAVA Flex will acquire 32 lines in both the phase direction (CV9) and the slice direction (CV10); to shorten the scan time, the technologist can reduce the number of lines to 24 in both directions without heavily compromising image quality. Essentially, fewer lines of k-space equal a shorter scan time.

In addition to changing the phase and slice settings for ARC, the technologist can run ARC in Turbo Mode (CV15) to speed up the scan—for a LAVA Flex scan, set Turbo ARC at 2, the fastest level. Turbo ARC adjusts the sampling pattern of k-space so fewer points are sampled. In general, the peripheral points are sampled less, and the key points in the center are sampled the same (Figure 3).

If the scan time is still not fast enough, the technologist can also change the order that k-space is filled. By changing the number 0 to 1 on the CV13 line, the technologist turns on Centric filling so that k-space data from the center is filled in the first one-third of scan time. By changing the number from 0 to 1 for Elliptical Centric (CV12), the k-space data from the center is filled in the first one-nineth of the scan.

Bolus detection methods

In addition to the techniques described above, the technologist can also use bolus detection methods to reduce scan time and maintain quality. Fluoro Triggering and SmartPrep are two methods that help the technologist ensure that the scan begins exactly at the time the contrast reaches the area of interest.

Fluoro Triggering allows the user to navigate through the patient's anatomy of interest while imaging the patient in real time. Simultaneously, gadolinium is injected and enters the patient's circulatory system. When the vessel of interest is filled with contrast, the user can start the scan. In this case, the first phase of the LAVA Flex scan should start when contrast is entering the hepatic arteries. Beginning the scan at this time ensures that the lesion's enhancement characteristics are seen throughout all of the phases.

With SmartPrep, the technologist places a tracker on the vessel of interest. When the injection begins, the system will monitor the tracker for T1 changes. When contrast arrives at the tracker, the LAVA Flex scan starts. This method is more automated than Fluoro Triggering, but will provide a similar outcome.

Conclusion

When imaging ailing patients, it is important to reduce breath-hold and still achieve a high-quality scan. Slightly dropping phase resolution, changing the settings for ARC, running ARC in turbo mode, and adjusting k-space filling can all help reduce breath-hold time while minimally impacting image quality. Using bolus detection methods such as Fluoro Triggering and SmartPrep can also help the technician ensure a high-quality scan. S

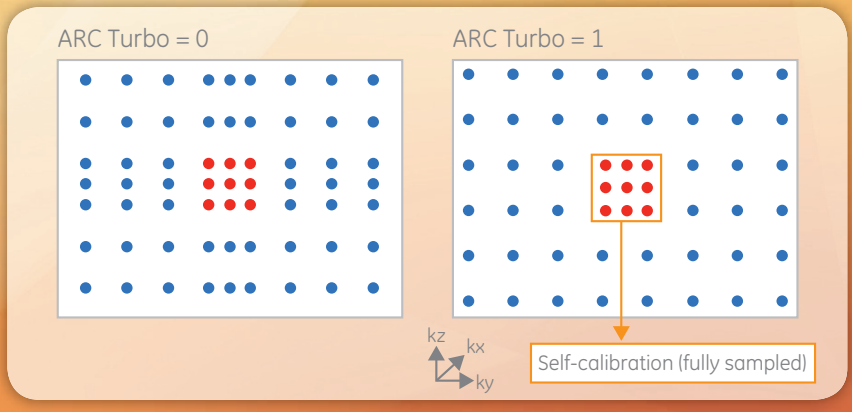


Figure 3.

Field Notes

HIGH-FIELD EXTREMITY MR IN SPORTS MEDICINE

Athletes praise the comfort, friendliness, and speed; radiologists receive the 1.5T image quality they require.

By Sami Kajander, MD, PhD, and Chief Radiologist, and Pekka Niemi, MD, PhD, and Radiologist; Hospital NEO, Finland

Linda Miettinen, an active gymnast, was scanned in a whole body MR system for a back problem. When her arm was recently injured, she was happy to be scanned using our extremity MR device instead, saying, "I felt relaxed because I could sit in a comfortable chair. The study was quick and easy for me." This is just one of the positive comments we've heard from extremity MR patients at our new private clinic, Hospital NEO, which opened in Turku, Finland last year.

Together with world-renowned sports medicine surgeons and specialists, we share a passion for diagnosing and treating sports injuries and musculo-skeletal (MSK) disorders. Although everyday runners and hockey players describe the majority of our patients, we have also diagnosed world class soccer players and other international athletes. The competence of our orthopedic surgeons is a main attraction for sports enthusiasts at every level, but the availability of advanced extremity MR imaging is also a lure.

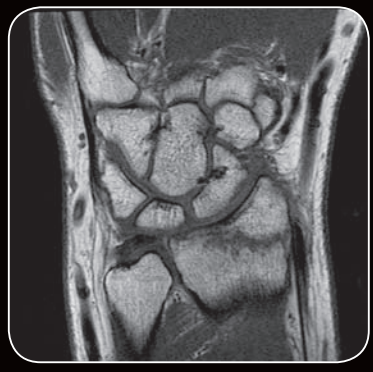


Figure 1. Occult wrist fracture: Fracture of the distal radius, invisible in radiographs. Coronal T1-weighted image, TR 475 ms / TE 13 ms.

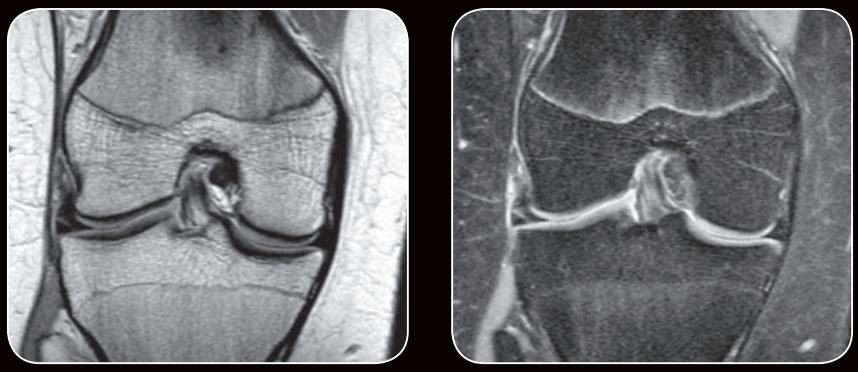


Figure 2. Tear of the lateral meniscus,not seen in a previous whole body MR study. Coronal PD FatSat images (TR 3000 ms / TE 16 ms). 480 x 224 matrix acq time 4:02.

Scoring with extremity MR

An extremity MR system is a specialized scanner capable of examining distinct, well-defined, three-dimensional cartilaginous regions of extremities. Because high-quality imaging is a top priority for Hospital NEO, we can't survive without a high-field extremity MR system. When the quality of care is imperative, but a smart investment is required, extremity MR is a practical solution.

Additionally, it's a perfect tool to study acute injuries because it has excellent sensitivity in detecting bone fractures—but its true superiority comes from its greater soft tissue contrast and, thus, versatility (as compared with CT and radiography). Plus, MR has the ability to show fractures that are missed with normal radiographs.

We selected an extremity MR system vs. a whole body MR scanner because it offers a combination of excellent image quality, patient comfort, moderate cost, and smaller space requirements.

"I felt relaxed because I could sit in a comfortable chair. The study was quick and easy for me."

Linda Miettinen, gymnast

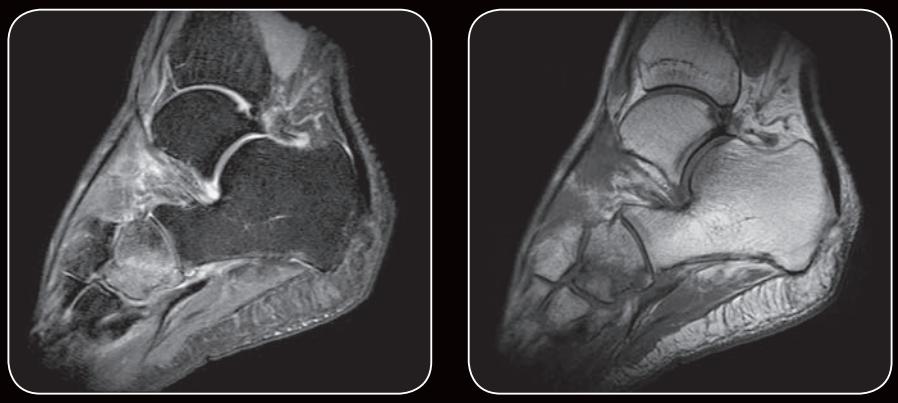


Figure 3. Fracture of the cuboid bone: suspected fracture in radiographs, confirmed by MR. Sagittal T2 FatSat images TR 2739 ms / TE 44 ms (left) 448 x 224 matrix, acq time 3:41.

Sagittal T1-weighted images, TR 882 ms / TE 10 ms 384 x 256 matrix, acq time 1:21.

Currently, the Optima* MR430s from GE Healthcare is the only MR scanner at our clinic, and it has surpassed our requirements. The surprisingly powerful specialty system offers breakthrough technology, delivering precise imaging with exceptional comfort, as well as the high-field, 1.5T image quality radiologists require.

The system was also chosen because GE provides reliable service and support, and our surgeons—who look at the MR images before operations—trust the image quality to assist in surgical planning. Furthermore, we can maintain a daily throughput of MR patients that is solid yet not extensive, which enables us to image patients flexibly and without delay. Currently, we are performing about 40-50 extremity MR studies per week. The knee is the anatomical region scanned most often, followed by the ankle and wrist. The injuries result from a vast range of sports, most commonly from soccer, running, and ice hockey.

Asking for it by name

The Optima MR430s is a leap forward in MR imaging because only the targeted anatomy— whether it's a knee, ankle, or wrist—needs to be inside the system while our patients recline comfortably in a padded chair. This is especially significant when MR scans are performed on claustrophobic and obese patients, and children. Parents can accompany their child into the scan room while he or she is being examined.

The word about such comfort has spread, and since it is the only extremity MR device in our part of Finland, patients contact Hospital NEO requesting the Optima MR430s. The positive feedback we've received has been encouraging; for example, professional athletes appreciate the fact that an MR extremity scan can be performed on site in a speedy, comfortable manner. Plus, everyday sports players have called their scans surprisingly easy, friendly, and not loud or scary.

Additionally, patients with claustrophobia praise the comfort of the specialty scanner. Public hospitals now request studies on the Optima MR430s, almost

Insight…

Shortly after RSNA 2011, GE Healthcare sold its 100th Optima MR430s extremity scanner. First worldwide orders of the scanner included one in Japan, one in Russia, and one in Chile.

Sami Kajander, MD, PhD,
is the Chief Radiologist at Hospital NEO.

weekly, for their claustrophobic patients. The difference between an extremity and a whole body system may be remarkable for claustrophobic or obese patients, and usually, they experience the scan without any difficulties.

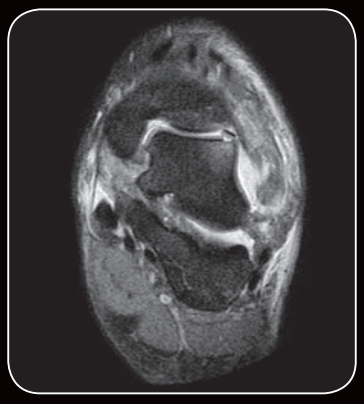


Figure 4. Flipped osteochondral fragment of the ankle: An osteochondral fragment of the talus has turned upside down. Coronal PD FatSat image
TR 2000 ms / TE 38 ms. 3 mm slice thickness, acq time 2:32, 380/224 matrix.

More than just comfortable

Unlike previous specialty systems, the Optima MR430s features a powerful 1.5T magnet. While patients relax with greater comfort, radiologists get the required image quality. This high-field image quality is a major factor in orthopedic medicine research, one of Hospital NEO's priorities. Using the Optima MR430s, we performed a pilot study showing that after viewing extremity MR scans, treatment was altered in 50% of patients.

Specifically, of 12 patients, 10 had a negative or slightly suspicious initial X-ray study. Of these 10 patients, six had one or several fractures shown in MR, and the others had bone contusions and/or ligamentous injuries. One patient was thought to have a fracture, but an MR extremity scan showed no fracture. Another patient had a suspected lunate fracture but after the Optima MR430s scan, it was shown to really be a fracture in the radial styloid. These results were presented at the Scandinavian-Japanese Society of Radiology meeting in Tokyo, in September 2012.

Changing the face of MR

Many radiologists like us agree that high-field, anatomy-specific imaging is the wave of the future for radiology departments. GE Healthcare's extremity scanner demonstrates the company's dedication to this kind of innovation—bringing tailored, personal, and friendly healthcare to more people. S

Pekka Niemi, MD, PhD

Sami Kajander, MD, PhD, *is the Chief Radiologist at Hospital NEO. He has been a radiologist since 1996 and has long-time experience in MSK and molecular imaging.*

Pekka Niemi, MD, PhD, *is a Radiologist at Hospital NEO, and he's also an Associate Professor at the University of Turku. He was a Research Fellow at Harvard University from 1992 to 1994, and he has been a radiologist since 1997. Dr. Niemi has long-time experience in MSK imaging.*

Hospital NEO *is a new private hospital that focuses on the diagnosis and treatment of MSK disorders. The hospital specializes in minimally invasive arthroscopic surgery, hand surgery, and the treatment of sports injuries.*

TWO NEW MR SYSTEMS, ONE CARING MISSION

GE Healthcare Continues its Human Element Focus

‡‡510(k) pending. Not available for sale in the USA.

Consider this: Every piece of equipment your facility owns represents a balance of technology and design. The new Optima* MR360 1.5T Advance‡‡ and Brivo* MR355 1.5T Inspire‡‡ from GE Healthcare not only exemplify this philosophy, they take it further.

Using the symbol of caring hands as inspiration, the new scanners—among the company's many strides in humanizing MR—were designed to be welcoming to the patient and intuitive for the technologist. GE Healthcare believes this focus on patient-centric design will help improve diagnostic confidence, patient outcomes, and productivity.

Each system was designed to offer different benefits—to fulfill the needs of facilities and patients. The Optima MR360 Advance was designed to bring into balance the advanced MR platform, combined with flexibility and efficiency. It should provide exceptional 1.5T performance, a comforting design, and advanced clinical applications to keep your diagnostic capabilities moving forward.

The Brivo MR355 Inspire was designed to make imaging more practical and easy to use, as its full capabilities are comfortably within reach. It's engineered to be intuitive yet effective so you will feel a renewed sense of confidence adding this diagnostic expertise.

Optima MR360 Advance

Insight...

GE's TiP Virtual Assistant applications training offers hands-on, on-site training from a distance. By connecting directly to the imaging console, technologists can observe GE Healthcare trainers as they demonstrate—then practice the steps themselves. Also, TiP Ed Online provides access to step-by-step guides and training materials, keeping valuable information at your fingertips.

Brivo MR355
Inspire

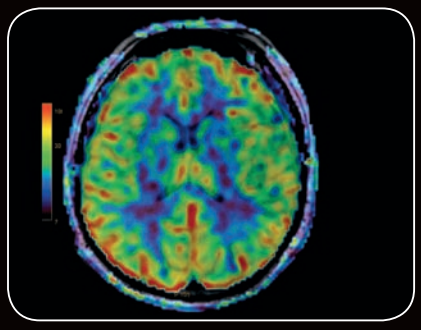
Caring design: MR in a new light

In 2011 GE Healthcare formalized a mission to optimize the MR patient experience while continuing to provide superb image quality. Visit or click **www.gehealthcare.com/humanizingmr.**

To further this mission, GE intends to offer a plethora of patient comfort features on both systems. For example, the patient table has been redesigned with adjustable heights to provide accessibility for patients of all sizes. Plus, a warm ambient light and a softened enclosure were added for a more familiar and inviting feeling. For those who require mobility for emergency patients, there will be a detachable table option.

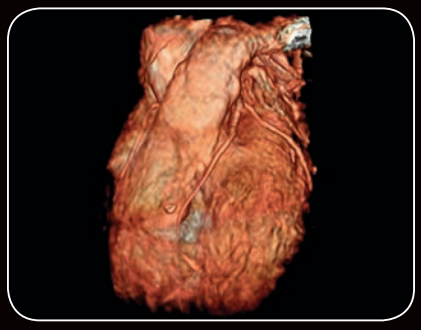
The Optima MR360 Advance is designed to include the Needle-Free Suite of applications. The Needle-Free Suite is currently available on other GE MR platforms for assessing whole liver parenchyma non-invasively, capturing arterial and venous flow in fine detail without contrast, or correcting for patient motion to potentially reduce the need for sedation.

Optima MR360 Advance



Brain
3D ASL axial
Fusion to BRAVO

C-Spine
T2 PROPELLER 3.0 sagittal
320 x 320 3 mm



Cardiac
3D Heart
224 x 256 2 mm

Empowered technology

With premium advancements, the Optima MR360 Advance and Brivo MR355 Inspire are intended to put you at the forefront of MR technology. For example, OpTix Optical RF is designed to offer high channel count, analog to digital-optical signal conversion where it matters—inside the scan room to minimize noise and signal degradation, but away from the patient to enhance comfort and safety. OpTix, currently available on other platforms, is intended to provide up to 27% higher signal-to-noise ratio over GE Healthcare's conventional, analog signal receivers, improving image quality and clinical confidence.

"We've been able to bring premium technologies like OpTix to both of these new systems, and make them standard on every system," offers Madhav Phatak, Optima MR360 Advance Product Manager at GE Healthcare.

Additionally, at the heart of both systems will be GE Healthcare's same proven, highly homogeneous magnet (typical ppm <0.06 ppm @ 30 cm DSV), used throughout the 1.5T product line, including the Discovery* MR450. The scanners are also intended to feature a large field of view of 50 cm x 50 cm x 48 cm. Plus, with energy-conscious, ecomagination-certified technologies like efficient gradients with a peak amplitude of 33 mT/m and a slew rate of 120 T/m/s, as well as water-cooling, super capacitors and a 28% lower PDU rating, the Optima MR360 Advance and Brivo MR355 Inspire are engineered to require 34% less energy than previous generation MR systems. Visit or click **www.ecomagination.com.**

Exam time well spent

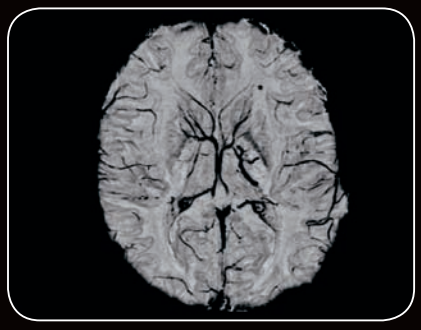
The time technologists have with patients is precious—not only the amount of time, but the quality of time. The Optima MR360 Advance and Brivo MR355 Inspire will offer Express Suite coils crafted to be intuitive and easy for technologists to use without sacrificing image quality.

The coils are paired with a new low-height table for easy patient access, even for larger patients, and there will be a detachable table option for fast emergency mobility. Together, these features will help get patients positioned quickly and comfortably.

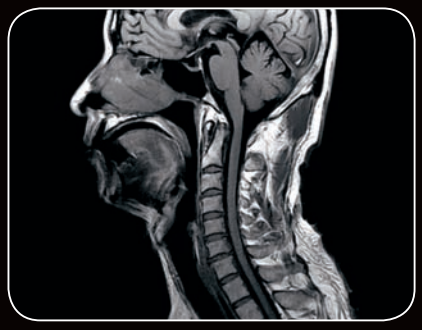
"It's easy to work quickly with a system, table, and coils when they're all designed to work together," comments Jim Wrenn, Express Suite Lead Coil Engineer at GE Healthcare.

Additionally, the Express Suite coil is designed to achieve outstanding coverage and penetration depth. This should enable high-quality head, spine, and body imaging, and the automatic coil selection helps enable quick and consistent exams. The Optima MR360 Advance will offer a wide array of high-element count RF coils, including a 16-channel head and neck array. With the new element anterior array coil, there's no need to reposition the patient for effective 56 cm SI coverage, which is a great productivity tool. The Brivo MR355 Inspire will boast a set of important coils that cover neuro, MSK, vascular, and body exams. The new 4-channel Flex coils that come in different sizes offer flexibility of scanning various anatomies.

Brivo MR355 Inspire



Brain
SWAN
384 x 320 1.8 mm



C-Spine
T1 FLAIR PROPELLER 3.0 sagittal
288 x 288

Knee
3D MERGE coronal
320 x 224 4 mm

The READY Interface, intended to be offered on both systems, streamlines workflow by offering simplified control of the scan parameters—allowing consistency from technologist to technologist and ultimately patient to patient. The intuitive READY Bar control condenses 30 inputs into a single control, and READY Brain software automatically determines slice thickness for brain scans resulting in more consistency and improved precision. The new Express spine annotation feature simplifies spine exams by allowing semi-automatic annotation of vertebral bodies on sagittal T2w spine imaging, potentially resulting in faster exam times.

Intuitive applications

Even with the right balance of design and technology, excellent breadth of high-quality clinical applications are what truly drive better understanding of what needs to be seen. The Optima MR360 Advance is designed to offer a long list of innovative applications from neuro to cardiac to body to help you utilize the full potential of 1.5T MR imaging. For example, the Needle-Free Suite of MR applications can provide potential cost savings for facilities, faster workflow for technologists, and a more comfortable imaging experience for patients by reducing the need for biopsies, contrast, and sedation.

The Optima MR360 Advance is intended to offer premium applications such as IDEAL IQ that provides quantitative information on fat content; 3D ASL that helps visualize tissue perfusion; and 3D Heart that allows easy whole-heart imaging for coronary arteries. The Brivo MR355 Inspire is designed to offer critical but easy-to-use applications, such as PROPELLER 3.0 which has low sensitivity to motion artifacts and high contrast-to-noise properties, and the Inhance non-contrast MRA Suite—designed to image vasculature of the brain, abdomen, and legs with excellent background suppression in short exam times.

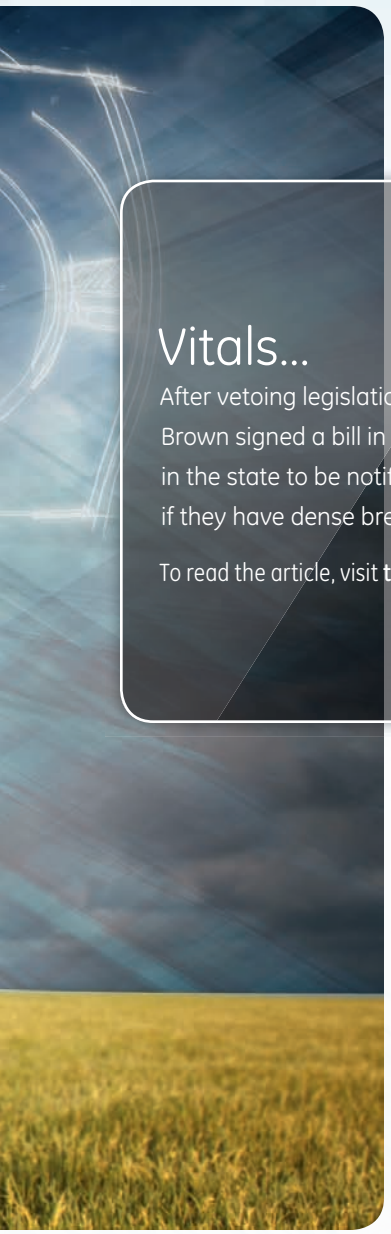
Go further

The Optima MR360 Advance and Brivo MR355 Inspire systems were designed with serviceability in mind. Along with GE Healthcare's customizable service plans, the company has a 25-year history of providing select, no-charge service enhancements to keep your systems and application capabilities up to date, ensuring you get the most out of your investment. Some key service features include:

- InSite* remote digital services enable GE Healthcare to reach out over broadband connections to understand and care for your critical equipment. Over 90% of field replacement units could be isolated with high confidence and short troubleshooting time.
- InSite OnWatch proactive technology can help avoid unplanned downtime by identifying service issues before they occur—even before you know anything is wrong.
- iLinq* allows you to request applications support and also receive a quick response from the company's technical experts, all at the touch of an on-screen button.

UNITING MODALITIES TO CREATE EFFICIENT CANCER CARE PATHWAYS

By Miriame Victor, Oncology Marketing Director, EU and EAGM, GE Healthcare



Vitals...

After vetoing legislation last year, California Gov. Jerry Brown signed a bill in September that requires women in the state to be notified following a mammogram if they have dense breast tissue.

To read the article, visit **tiny.cc/spa1202**

DIGITAL DIVE

MR, CT, and x-ray rely on a technique of capturing images in slices called tomography. Check it out in action: **tiny.cc/spa1201**

The majority of people reading this article know someone who has cancer. The statistics are staggering: across 40 European countries, there were an estimated 3.2 million new cases of cancer and 1.7 million deaths from cancer in 2008.[1] According to the American Cancer Society (ACS), in 2012, about 577,190 Americans are expected to die of cancer—more than 1,500 people a day. Cancer is the second most common cause of death in the US, exceeded only by heart disease, accounting for nearly one of every four deaths.[2]

Cancer is an enormous global health burden, touching every region and socioeconomic level. Today, cancer accounts for one in every eight deaths worldwide—more than HIV/AIDS, tuberculosis, and malaria combined. In 2008, there were an estimated 12.7 million cases of cancer diagnosed and 7.6 million deaths from cancer around the world. Moreover, the global cancer burden is growing at an alarming pace; in 2030 alone, about 21.4 million new cancer cases and 13.2 million cancer deaths are expected to occur, simply due to the growth and aging of the population.[2]

Efficient care pathways: modalities united

The good news is that the ACS reports the five-year relative survival rate for all cancers diagnosed between 2001 and 2007 is 67%, up from 49% from 1975 to 1977. The improvement in survival reflects both progress in diagnosing certain cancers at an earlier stage and improvements in treatment.[2]

Innovations in cancer screening, diagnosis, treatment, and treatment monitoring have resulted in a remarkable improvement in survival rates, as well as a substantial increase in information that is shared by mutidisciplinary teams (MDT). Efficient care pathways are critical for any oncology center and require this multidisciplinary

approach—defined by multiple, complementary modalities (MR, CT, PET/CT, ultrasound, and x-ray) and multiple clinical specialties (the medical oncologist, radiographer, and radiologist; plus nurses, surgeons, and pathologists). An oncologist will recommend MR, CT, or PET/CT at various stages of the oncology care pathway, as each modality has differences and synergies.

Personalized cancer management beyond imaging

Through GE Healthcare's healthymagination initiative and the continuation of our Humanizing MR mantra, we are on the leading edge of this multidisciplinary approach. Our global fight against cancer is backed by a five-year, $1 billion commitment to improve diagnosis to help doctors and patients fight more effectively. Because the cost of cancer care is growing, we strive to assist patients in finding a more efficient care pathway, moving them along to treatment more quickly.

For example, GE Healthcare is driving the change toward efficient patient care pathways through our new Oncology Solutions program, a comprehensive suite of tools offering solutions from screening to treatment monitoring—enabling personalized cancer care and efficient communication during MDT meetings. The mission is to help your oncology MDT improve patient care with the essential components you need for quality cancer management; in turn, providing your patients with an efficient and accurate diagnosis, as well as a personalized care experience.

With these tools, we can offer your facility a new strategy around care pathway management and therapeutic approaches, designed to address your need for accurate and efficient cancer care. Take breast cancer, for example—ranking second (after lung cancer) as a cause of cancer death in US women.[2] The GE Healthcare program goes beyond imaging, offering your facility:

- A one-stop shop, including SenoBright* (contrast enhanced spectral mammography), breast MR, molecular breast imaging, whole body PET, Mammostrat, tissue multiplexing, ASiST, and patient information management;
- A screening program, including a call center, care pathway management, the choice of a mobile or fixed clinic, medical community training and education, staffing optimization, an awareness campaign, and research studies;
- Diagnosis, including MR with dynamic contrast enhanced (DCE), ultrasound, molecular breast imaging and diagnostics, and OncoQuant;
- Biopsy, including MR with DCE, Senographe* Essential Interventional, ultrasound, and ASiST;
- Staging using PET/CT, MR with DCE, and OncoQuant;
- The ability to identify the risk of reccurrence using Mammostrat;
- Treatment monitoring, including PET/CT, PET VCAR, MR with diffusion weighted imaging, AdvantageSim MD, ultrasound, and circulating tumor cells; and
- Patient information management, including archiving, image exchange for radiology and pathology, and workflow management.

Miriame Victor,
Oncology Marketing Director,
EU and EAGM, GE Healthcare.

To date, GE Healthcare has launched these programs in several underserved markets, such as the state of Wyoming, USA, Saudi Arabia, and China. Additionally, as part of our healthymagination initiative, we invested in companies in IT, hospital project management, and pathology that provide solutions beyond imaging; for example, Clarient (in vitro diagnostics), NanoString (transitional research and molecular diagnostics), Omnyx (digital pathology), and CheckCap (ingestible capsule for 3D colon imaging).

There are several breast cancer innovations now in the pipeline. We're also bringing new weapons by increasing access to mammography screenings in underserved areas—for example, in September the GE Mammovan hit the roads of Wyoming, which has one of the lowest breast cancer screening rates in the country.

Furthermore, your facility can take advantage of two clinical decision making tools. OncoQuant is designed to save you time in preparing MDT meetings, collect and share your patient history in a structured manner, include multi-modalities and vendors, and access all oncology applications in one click. MD Connect is a dedicated oncology server, allowing you to share information/results between departments and with the patient, and access tools wherever and whenever you need them.

We offer similar multi-modality programs and therapeutic approaches for lung cancer, colorectal cancer, non- and minimally-invasive oncology procedures, and radiation oncology. Thanks to the depth and breadth of our Oncology Solutions tools, ranging between in vivo and in vitro diagnostics, we were able to display our breast and lung cancer care pathways at the 2012 Congress of the European Society of Medical Oncology. Among all cancers, lung cancer is the No. 1 killer worldwide due to late detection. Our goal is to help you set an integrated solution to assist in detecting lung cancer earlier and help you save patients' lives.

The global fight

GE Healthcare is a leader in diagnostic imaging for the detection of cancer and is a leading provider of technologies for cancer research and biopharmaceutical manufacturing. In MR, this reinforces our focus on the development of technologies such as metabolic imaging with hyperpolarized Carbon 13‡‡ (C13) for research and biopharm manufacturing activities. To further accelerate and help enhance the development of metabolic imaging and other innovative technology, GE has launched a new entity, Research Circle Technology, Inc. (RCT). RCT's vision is to create a strong alliance between GE's scientists and the world's leading universities, providing easy access to GE's organic technology and wide scope of healthcare expertise in an open innovation structure.

Our ultimate mission is to collaborate with our customers and the oncology industry to create and enhance multi-modality partnerships—providing patients with a more personalized care pathway and a more rapid diagnosis; in turn, helping to eliminate cancer as a major worldwide health problem. Because cancer knows no boundaries, our mission extends globally.

1. www.ejcancer.info/article/S0959-8049(09)00926-5/abstract.
2. www.cancer.org/acs/groups/content/@epidemiologysurveilance/documents/document/acspc-031941.pdf.
3. www.auntminnie.com/index.aspx?sec=sup&sub=wom&pag=dis&itemid=100673&wf=5104

‡‡CAUTION: Sterile compounding equipment. Output of this equipment may only be used for human applications under an approved research study (IND or equivalent).

Ultrasound is not cleared or approved by the FDA for breast cancer screening.

NEXT GENERATION NEURO IMAGING CLINICAL RESEARCH

By Akira Kunimatsu, MD, PhD, Associate Professor of Radiology,
The University of Tokyo Hospital, Japan

The latest GE Healthcare wide bore MR system, Discovery* MR750w 3.0T, was installed in The University of Tokyo Hospital in Spring, 2012 as part of a new five-year national healthcare project in Japan. In accordance with this project, the relevant ministries and government agencies have created a list of R&D tasks, including the development of innovative drugs, medical devices, and technologies. The medical researchers and healthcare industries in Japan are being encouraged to achieve these goals during the next several years.

MR has been an established tool to measure certain biomarkers of the human brain.[1] Clinical biomarkers available on MR include: brain volume (measured by using 3D T1-weighted imaging); diffusivity of the brain tissue and anatomical connectivity of the white

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The University of Tokyo Hospital.

matter (diffusion weighted imaging and diffusion tensor imaging); brain tissue metabolism (MR spectroscopy); cerebral blood flow (arterial spin labeling methods); and functional connectivity or networks in the brain (task-functional MR and resting-state functional MR). Across all these applications, MR biomarkers share one common nature—they all can be quantified.

The evaluation of response to new drugs or new medical technologies by using MR biomarkers requires at least two MR scans: quantification before and after the intervention. On the other hand, a larger number of participants would give more robust results. So, demands on longitudinal follow up and data correction at multiple institutions have been increasing. Moreover, researchers would like to detect very subtle changes of MR biomarkers among serial scans in order to prove the usefulness of a new product. However, the accuracy of quantification with MR has not been fully discussed.

For example, if you have your brain scanned on an MR today and again on a different scanner tomorrow, will the same results be obtained? Most people will answer "yes" to this question. Even if the measurement results from two sessions are considerably different, people will ascribe the difference to "random" errors. However, in addition to these random errors, recent research has unveiled the presence of "systematic" errors inherent to each MR system possibly affecting measurement results.

It has been reported that inter-scanner variability may have a substantial effect on brain volume measurements when using MR.[2,3] Differences in MR vendor systems and magnetic strength have been reported as providing significantly different results. Additionally, different results may be due to the analysis software in diffusion tensor imaging and cerebral blood flow measurement with arterial spin labeling techniques, since algorithms adopted by the software are considerably different from each other and the algorithms usually require many

Figure 1. The Discovery MR750w installed at The University of Tokyo Hospital.

assumptions and a-priori constants. In many cases, these assumptions and constants are arbitrarily assigned by the manufacturers. With the calculated results inevitably depending on the software, variance is very possible.

So, what can be done to minimize the systematic errors of MR? The Discovery MR750w may give us one solution. It provides excellent B0 homogeneity in the wide bore 3.0T MR class (0.27 ppm at 40 cm DSV). With the four-point RF transmit system, we can obtain fast and robust Bloch-Siegert shift estimation of local B1 inhomogeneity to gain a homogeneous RF transmission and eliminate a local SAR hot spot.[4] Gradient nonlinearity is another main problem that may cause scanner instability of MR; however, the system offers a gradient nonlinearity correction technique on a 3D basis.

The spacious wide bore nature of the Discovery MR750w, equipped with soft and comfortable GEM coils, provides examinees with great comfort that they have likely not experienced before in an MR scan. This feature would strengthen the value of the scanner beyond the heightened machine capabilities mentioned above.

In summary, MR has been established to measure biomarkers of the human brain. The research trend shows an increase in multi-center or longitudinal studies, and therefore the quality control of MR will become more important. I believe that the Discovery MR750w is an ideal solution for both medical research and daily clinical practice.

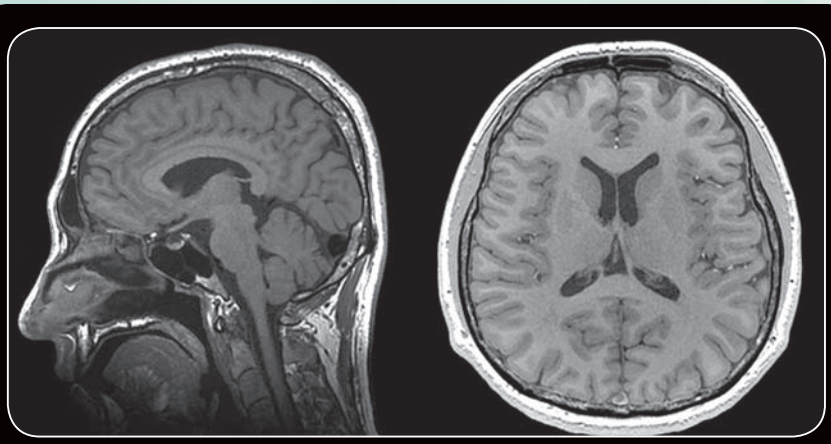

Figure 2. 3D Cube T1: TE/TR = 11/440; slice thickness = 1.2 mm; matrix = 512~512 (left). 3D FSPGR: TE/TR = 2.3/8.0; slice thickness = 1.2 mm; matrix = 512~512 (right).

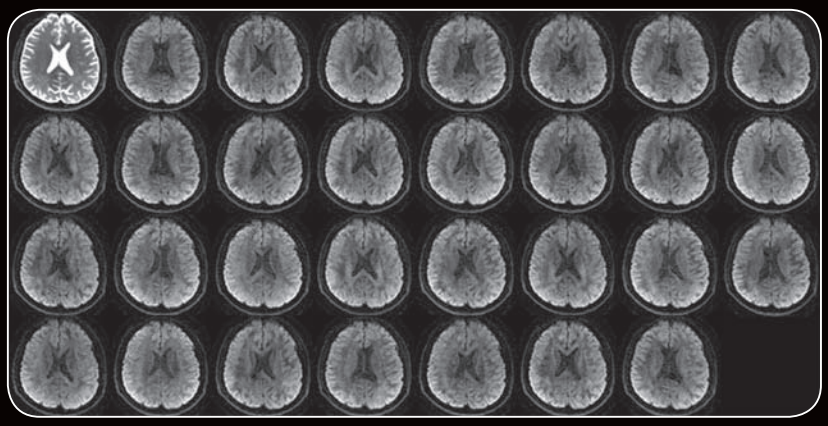

Figure 3. DTI: TE/TR = 82/10600; slice thickness = 3 mm; matrix = 256~256; 30 directions; b = 1000 sec/mm^2.

References

1. Jack CR, Jr., Bernstein MA, Borowski BJ, et al: Update on the magnetic resonance imaging core of the Alzheimer's disease neuroimaging initiative. Alzheimers Dement. 2010; 6: 212-220.
2. Jovicich J, Czanner S, Han X, et al: MRI-derived measurements of human subcortical, ventricular and intracranial brain volumes: Reliability effects of scan sessions, acquisition sequences, data analyses, scanner upgrade, scanner vendors and field strengths. Neuroimage. 2009; 46: 177-192.
3. Takao H, Hayashi N, Ohtomo K: Effect of scanner in longitudinal studies of brain volume changes. J Magn Reson Imaging. 2011; 34: 438-444.
4. Sacolick LI, Wiesinger F, Hancu I, et al: B1 mapping by Bloch-Siegert shift. Magn Reson Med. 2010; 63: 1315-1322.

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The University of Tokyo Hospital *is located north east of the center of Tokyo, Japan. The hospital has 1,000 inpatient beds and more than 3,500 patients visit the outpatient clinic each business day.*

ADVANCED MR BECOMES ACCESSIBLE TO PATIENTS IN INDIA

GE Healthcare's healthymagination initiative commits to making diagnostic technology attainable and cost effective in developing countries.

The goal of helping physicians and hospitals throughout the world to provide a higher level of healthcare to more people—and save costs in the process—is at the core of GE's healthymagination initiative. In rural India, healthymagination is at work bringing MR technology to many people living at or below the poverty line.

One example is Agartala, a typical Indian town replete with busy market-places, historical monuments, bustling business centers, and peaceful residential colonies. Nestled amidst lush green hills and verdant valleys, Agartala is the capital of the northeastern state of Tripura. Though the most developed city in the state, it does not have diverse high-quality medical services accessible to the large population in and outside of the city.

Should I stay or should I go?

Prior to December, 2011, there was only one 0.2T MR serving all of Tripura, a state with a population of 3.5 million. Patients—adults and children alike—traveled far and wide to larger cities for advanced MR study. This cost money and time, and it was painstaking for patients. "The entire northeast was quite deficient in terms of healthcare. In Tripura, there was no private hospital with a good MR facility," says Aruna Tantia, MD, Director of ILS Hospital in Kolkata. "Most of the people of Tripura were heading to southern India or Calcutta for their MR scans."

According to a patient in Agartala, medical science had developed and progressed across much of India, but not in Tripura—it really lagged behind. When people fell ill, they had to go out of the state for care. Puneet Gupta, MD, Head of Radiology at ILS Hospital,

Vitals...

India recorded the highest growth rates in the mid-2000s, and is one of the fastest-growing economies in the world. India has recorded a growth of over 200 times in per capita income in a period from 1947 to 2011. The growth was led primarily due to a huge increase in the size of the middle class consumer, a large *labor force*, growth in the manufacturing sector due to rising education levels and engineering skills, and considerable foreign investments. India is the *19th largest exporter* and *tenth largest importer* in the world.[1]

points out how serious the situation was. "Many patients couldn't travel, and they really suffered—especially when it came to needing MR scans. In emergency situations, some patients even lost their lives."

Several citizens recall their difficult situations. For example, a father's son had an accident that left him with fractured legs, an injured neck and backbone, plus a serious head injury. After being informed that his son was serious, the father thought about taking his son elsewhere, as he wasn't sure of the MR and other medical services available in Tripura.

Additionally, as told by the son of a patient, his mother had a brain stroke and her blood pressure was very high. There were no MR systems available, and after three days she hadn't been provided with any medical treatment, or even basic reports. In a different situation, according to a concerned mother, her son was suffering from a severe stomach ache. The doctor provided medicine for three months but he wasn't recovering. After seeing the sonography reports, the doctor recommended that she take him to Agartala. She did, but the new doctor said they should travel to Kolkata for treatment; however, that trip was not affordable.

MR today for a healthier tomorrow

It is critical that cost, quality, and access barriers are addressed so people, irrespective of where they live in India, have access to affordable, quality healthcare—including MR imaging. To help make that a reality, in December 2011, ILS Hospital purchased GE Healthcare's Brivo* MR355 1.5T MR system—bringing advanced neurological, cardiovascular, oncology, and arthropedic MR imaging to Tripura and the rest of northeast India.

The Brivo MR355 is part of the GE healthymagination initiative to make advanced diagnostic technology accessible and cost effective worldwide. As mentioned earlier, the aim of the initiative, which includes a $6 billion commitment from GE through 2015, is to innovate smarter processes and technologies that help physicians and hospitals throughout the world provide a higher level of healthcare to more people—and save costs in the process.

The initiative is in synch with the company's commitment to bring advanced MR technology within reach of India's residents, while providing greater image quality, value, new levels of simplicity, upgradeability, and lower costs. "We are at work for a healthier India by bringing high-field, superconducting MR to healthcare institutions and patients, making it reachable for them," offers Dr. Karthik Kuppusamy, Director of MR, GE Healthcare India and Southeast Asia.

Dr. Tantia says she and her staff are seeing positive results from the new MR system. "We want the people of Tripura to be healthy, and we want to use the preventative aspect of the medicine so that problems can be diagnosed

Insights...

Combining breakthrough simplification technology and advanced diagnostic capability, the Brivo MR355 1.5T is an affordable scanner that has the potential to make MR technology accessible worldwide to hundreds of thousands of new patients who go without MR due to traveling constraints, long waiting lists, or unaffordable care.

at an early stage. We hope to make a considerable impact in the population's health." A patient in Agartala is also very optimistic, noting that the Brivo MR355 has brought new rays of hope into people's lives because they don't have to go elsewhere for MR exams anymore.

Advanced, patient-centered technology

According to Dr. Gupta, before the arrival of the Brivo MR355, the facility was not able to diagnose blockages in the pancreatic or cystic duct, or perform a proper MR cholangiopancreatography. However, with this 1.5T system, the exams can be done very nicely. Also, with diffusion-weighted imaging of the head, neck, and the rest of the body, the technicians don't have to change a coil, saving time.

Arindom Debbarma, MD, a radiologist at ILS Hospital, is impressed with the new MR system. "We can perform advanced studies of the brain, and even of the spine and vessels of the body. We can do MR angiography and even functional studies of the brain. In cardiovascular cases we can see the screened anatomies of the heart." Additionally, a patient's father shared his renewed confidence by saying, "I am now very happy with this hospital. They saved the life of my son with this technology, which was previously not available."

Healthymagination is all about becoming healthier through the sharing of imaginative ideas and proven solutions. Because of the initiative, over 450 MR centers are serving patients across India today. GE Healthcare goes beyond innovations in the fields of technology and medicine, celebrating the people behind these advancements and seeking to build stronger relationships between patients and doctors.

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References

1. http://en.wikipedia.org/wiki/Economy_of_India.

Aruna Tantia, MD

Aruna Tantia, MD, *is director and unit head of minimally invasive gynecology at ILS Hospital in Kolkata, India. Dr. Tantia is also a visiting gynecologist at ILS Hospital in Agartala. She obtained her MBBS degree from Rabindra Nath Tagore Medical College, Udaipur (Rajasthan University) in 1986.*

Puneet Gupta, MD, *is head of radiology at ILS Hospital in Agartala, India. Prior to joining ILS Hospital, Dr. Gupta worked as head of the imaging department at New Central Polyclinic and Ibnsina teaching multispeciality hospital in Sirte, Libya.*

ILS Hospital in Agartala, *India provides the citizens of Tripura, and neighboring states, with a 200-bed, state-of-the-art, multi-specialty hospital. Residents do not have to travel far to access quality, reliable treatment in all areas of specialization, including cardio and neuro. The hospital is considered a center of excellence for minimal access surgery in gastroenterology, gynecology, urology, and orthopedics.*

Puneet Gupta, MD

WHAT DOES THAT MEAN?

A quick guide to commonly used terms and acronyms for GE Healthcare MR sequences and parameters.

Industry MR Terms	
Sequence Type	**GE Acronyms**
Spin Echo	SE
Gradient Echo	GRE
Spoiled Gradient Echo	SPGR
Coherent Gradient Echo	GRASS
Steady-state Free Precession	SSFP
Balanced Gradient Echo	FIESTA
FIESTA with Dual Excitation	FIESTA-C
FIESTA with Elliptic-centric k-space Filling	COSMIC
Multi-Echo Recombined Gradient Echo	MERGE
Ultrafast Gradient Echo	Fast GRE, Fast SPGR
Ultrafast 3D Gradient Echo	3D Fast GRE, 3D Fast SPGR
3D Volume FSPGR with IR Prep	LAVA
3D Volume FSPGR with Fat/Water Separation	LAVA Flex
Diffusion Weighted Imaging	DWI
enhanced Brain and Body Diffusion	eDWI
Dynamic MRA with k-space Manipulation	TRICKS

Industry MR Terms	
Sequence Type	**GE Acronyms**
High-resolution Bilateral Breast Imaging	VIBRANT
High-resolution Bilateral Breast Imaging with Fat/ Water Separation	VIBRANT Flex
Non-contrast MR Angio, FSE-based	Inhance DeltaFlow
Non-contrast MR Angio, Phase-contrast Based	Inhance 3D Velocity
Non-contrast MR Angio, Gated 2D	Inhance 2D Inflow
Non-contrast MR Angio, FIESTA-based	Inhance Inflow IR
T2 Mapping	CartiGram
Single-slab 3D Fast Spin Echo	Cube
Arterial Spin Labeling	3D ASL
Diffusion Tensor Imaging	DTI
DTI Tractography	FiberTrak
Motion Correction with Radial Blades	PROPELLER
MR Elastography	MR Touch
Fat-water Separation	IDEAL

Industry MR Terms	
Sequence Type	**GE Acronyms**
Brain Spectroscopy	PROBE
Breast Spectroscopy Exam	BREASE
Prostate Spectroscopy	PROSE
Inversion Recovery	IR, MPIR, FastIR
Short Tau IR	STIR
Fluid Attenuated IR	FLAIR
Turbo Spin Echo/Fast Spin Echo	FSE
Single-shot FSE/TSE	SS FSE
FSE/TSE with 90° Flip-Back Pulse	Fast Recovery FSE (frFSE)
Echo Spacing	ESP
Echo Planar Imaging (EPI)	EPI
Echo Train Length	ETL
Apparent Diffusion Coefficient Map	ADC
Navigators for Cardiac Imaging	Navigators
Parallel Imaging	ASSET
Self-calibrating Parallel Imaging	ARC
Contrast Bolus Timing/Visualization	Smart Prep; FluoroTrigger

Industry MR Terms	
Sequence Parameters	**GE Acronyms**
Repetition Time, Echo Time (in msec)	TR, TE
Averages	NEX
Scan Measurement Time	Acquisition Time
Distance Between Slices	Spacing
Shifting Slices Off-center	Off-center FoV
Field of View (FOV)	FOV [cm]
Rectangular FOV	Partial FOV (PFOV)
Bandwidth	Receive Bandwidth [kHz]
Variable Bandwidth	Variable Bandwidth
Phase Oversampling	No Phase Wrap
Time Delay	Time Delay
Half Fourier Imaging	Half NEX; Fractional NEX
Partial Echo	Fractional Echo
Gradient Moment Nulling	Flow Comp
Ramped RF Pulse	Ramped Pulse
Magnetization Transfer Contrast	MTC
Prep Pulse Fat Saturation	FatSat/Chem Sat
Suppression of Signal	SAT
Scan Synchronization with ECG	Cardiac Gated/Triggering
Trigger Delay	TD
Multi-Channel RF Coil Sensitivity Normalization	PURE, SCIC
Central k-space Filling Arterial Visualization	Elliptic Centric

EXTREMITY MAGNETIC RESONANCE IMAGING:

An economically prudent choice in the accurate diagnosis of scaphoid fracture

By Nigel Raby, MBChB, MRCP, FRCR, Consultant Radiologist, Western Infirmary, Glasgow University Hospitals, UK; Ann-Marie Chapman, Sumit Sharan, and Chaitanya Sarawate; GE Healthcare

Scaphoid fractures account for 79% of all carpal fractures and are almost always caused by a fall on the out-stretched hand.[1] Most scaphoid fractures are detected on initial plain radiographs. For patients with clinically suspected scaphoid fracture and a negative initial radiograph, patient management involves immobilization and re-evaluation after two weeks. Clinical follow up with repeat radiographs is continued until a definitive diagnosis and/or complete resolution of symptoms is achieved.[2] However, this approach results in immobilization of the wrist leading to increased health services utilization and loss of productivity in numerous patients, many of whom do not have an underlying fracture.[2]

MR—and specifically extremity MR—has been suggested as a method for early and accurate diagnosis of scaphoid fractures that may reduce downstream medical costs and avoid loss of productivity. It is highly sensitive and non-invasive, and it may identify bone contusions and ligamentous injuries.[3]

A meta-analysis of several studies has shown MR to be more sensitive and specific than plain radiographs in the detection of scaphoid fractures.[4] In a six-year review, Dorsey et al stated that 75% of patients with positive clinical findings indicative of a scaphoid fracture do not have a fracture. Of those who do have a fracture, approximately 7% are not visible on initial plain radiographs.[5]

Nigel Raby, MBChB, MRCP, FRCR,

has practiced as a Consultant Radiologist at the Western Infirmary and Gartnavel General Hospital since 1992.

A comparative analysis of the accuracy, diagnostic uncertainty, and cost of imaging modalities (MR and CT) in suspected scaphoid fracture was carried out in 2008. In the study, MR was shown to be superior to CT[3] and the authors suggested that MR might be considered the gold standard due to its advantages of detecting soft-tissue injuries and avoiding ionizing radiation.[3]

A British study published in 2005 found that direct costs of MR for diagnosing scaphoid fracture did not significantly increase healthcare costs. A normal MR scan excludes a fracture. Such patients (75% of cases) can avoid unnecessary immobilization and return to work, thus minimizing productivity losses. These patients do not require any further clinical or radiology follow up that consequently translates to significant healthcare savings.

Given the potential for improved diagnostic accuracy using MR, which is also cost-neutral or potentially cost-saving, GE Healthcare with help from Nigel Raby, MBChB, MRCP, FRCR, Consultant Radiologist, Western Infirmary, Glasgow University Hospitals, Scotland, conducted a study to assess the potential economic impact of the targeted use of an extremity MR scan along with radiography—compared to radiography alone—in the diagnosis of suspected scaphoid fracture.

Economic impact of MR

Using data encompassing a period of one year from the radiology department at Western Infirmary, we constructed a flow chart of a hypothetical cohort of 100 patients, aged 20 to 60 years old, presenting to the Accident & Emergency Department (A&E) with symptoms of clinical scaphoid fracture. As shown in Figure 1, presentation to the A&E was followed with a diagnostic work up of the scaphoid through a series of radiographs. Patients diagnosed with scaphoid fracture from the initial radiograph were treated for the scaphoid fracture. However, in cases of a negative or indeterminate/ unknown radiograph, the patients were either discharged based on clinical findings or treated with a cast/ splint with clinical follow up and repeat radiographs—the current standard of care (SOC). In the alternative care pathway, patients with indeterminate/ unknown initial radiographs who were not discharged underwent an MR of the wrist and, based on these findings, were either discharged or treated.

Figure 1. Flowchart showing SOC (x-ray) and alternate (MR) pathways.

The numbers adjacent to the decision boxes provide the flow of patients through them. It assumes 100 patients walk into the A&E and the different pathways they undergo to recieve the treatment. The numbers are based on clinical data collected at Dr. Nigel Raby's hospital.

Common for both SOC and alternate pathways

Model Analysis — comparison between SOC and alternate pathway

Data sources

Costs of various services and procedures used by patients during either the SOC or the alternative care pathways were obtained from the NHS Admitted and Outpatient Patient Tariff.[7] Information on the employment and wage rates were obtained from the Labor Force Survey conducted by the Department of National Statistics of the UK.[8] Data inputs used in the model are shown in Table 1A and Table 1B.

Duration for complete treatment resolution is provided in Table 2.[3] Literature estimates (based on PubMed and Ovid Website searches to identify all pertinent English-language publications related to scaphoid fractures published in peer-reviewed medical journals from 2001 to 2010) and data collected by Dr. Raby showed that by utilizing an MR scan, the time to reach a definitive diagnosis was two days. These patients could be correctly treated or discharged. The SOC pathway would take between 10 days and six weeks. The alternate pathway also eliminates the need for unnecessary imaging of patients and subsequent follow-up outpatient visits (Table 3).

Results

It was found that MR scanning in patients presenting with wrist injury at the A&E could potentially save £76,133 per year per Primary Care Trust (PCT). The major drivers of the savings to the PCT are the avoidance of follow-up outpatient visits and unnecessary treatment. The savings achieved from reduction in lost productivity was

Population parameters	Estimated values
Annual prevalence of scaphoid fracture in UK population[9]	0.14%
Prevalence of scaphoid fracture among patients presenting to A&E with wrist injuries/pain[2]	19%
UK population[8]	61,792,000
Population of an average UK PCT	500,000

Table 1A. Estimated population parameters used in the model.

Reimbursement values (all costs are reported in 2010 GBP)	Estimated values
Initial orthopedic outpatient appointment (including MR)[7]	£143
Follow-up orthopedic outpatient appointment (including x-ray)[7]	£86
Average travel cost per visit[8]	£13
Average daily wage rate[8]	£41

Table 1B. Estimated reimbursement values used in the model.

Pathway adopted	Investigational modality	Duration of resolution
Alternate pathway	Extremity MR detection (+ve scaphoid)	60 days
	Extremity MR detection (-ve scaphoid)	2 days
SOC/conventional pathway	x-ray detection (+ve/-ve scaphoid)	42 days

Table 2. Comparison of pathways affecting time of treatment resolution.

Source: estimates from Dr. Nigel Raby, Western Infirmary, Glasgow University Hospitals.

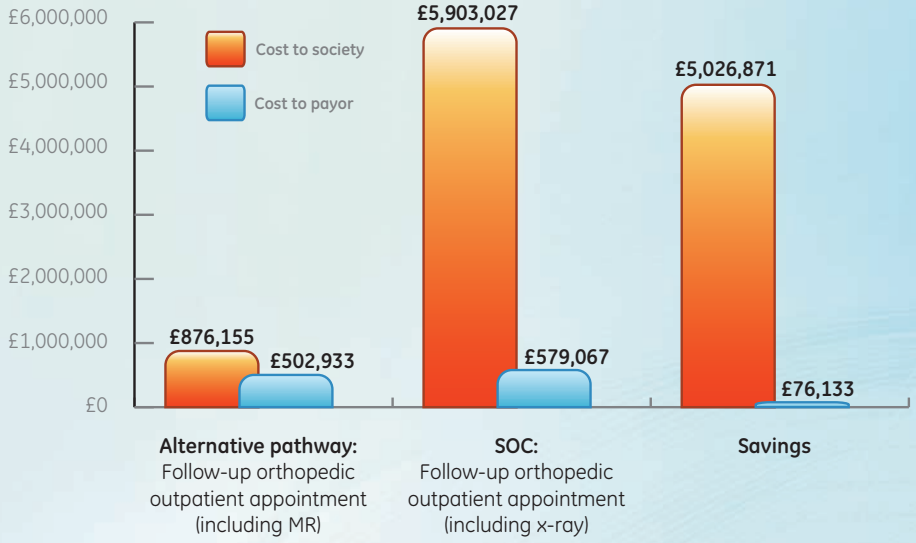
Health services	Utilization per episode		
	x-ray arm (SOC)	MR arm (alternate care)	
Scaphoid status	-ve/+ve scaphoid	-ve scaphoid	+ve scaphoid
No. of follow-up outpatient visits	2	0	1

Table 3. Average resource utilization during SOC and alternative care pathway in detecting scaphoid.

Source: estimates based on literature review.[3]

	Cost to payor	Cost to society
Alternative pathway: follow-up orthopedic outpatient appointment (including MR)	£502,933	£876,155
SOC: follow-up orthopedic outpatient appointment (including x-ray)	£579,067	£5,903,027
Savings	£76,133	£5,026,871

Table 4. Model results (annual costs).



potentially substantial at £5,026,871 (85% less cost compared to SOC pathway) as shown in Table 4. These estimates are driven primarily by preventing immobilization of the arm, which often results in a loss of work days, in patients who do not have a scaphoid fracture but have a radiological inconclusive result.

Conclusion

Use of an extremity MR scanner in patients presenting to the A&E with wrist injuries and clinically suspected scaphoid fractures could potentially lead to savings for the payor due to the avoidance of unnecessary treatment. In addition, there are significant potential savings from a societal perspective due to the reduction in lost productivity as compared to using the current SOC. Extremity MR will not only detect scaphoid fractures but may be used to detect other wrist fractures, such as distal radius, capitate, and metacarpal. Consideration of the benefits associated with early detection in this analysis may further improve the results.

References

1. Smith M, Biam GI, Turner PC, Watts AC. Review of Imaging Scaphoid Fractures. ANZ journal of Surgery. 2010;80:82-90.
2. Brydie A, Raby N. Early MR in the management of clinical scaphoid fracture. Br J Radiol. 2003; 76(905):296-300.
3. Jenkins PJ, Slade K, Huntley JS, Robinson CM. A comparative analysis of the accuracy, diagnostic uncertainty and cost of imaging modalities in suspected scaphoid fractures. Injury. 2008;39:768-74.
4. Yin ZG, Zhang JB, Kan SL, Wang XG.; Diagnosing suspected scaphoid fractures: a systematic review and meta-analysis. ClinOrthopRelat Res. 2010;468:723-34.
5. Dorsay TA, Major NM, Helms CA. Cost effectiveness of immediate MR imaging versus traditional follow-up for revealing radiographically occult scaphoid fractures. AJR. 2001;177:1257-63.
6. Brooks S, Cicuttini FM, Lim S, Taylor D, Stuckey SL, Wluka AE. Cost effectiveness of adding magnetic resonance imaging to the usual management of suspected scaphoid fractures. Br J Sports Med. 2005;39:75-9.
7. NHS Admitted and Outpatient Patient Tariff 2011. Available at www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_124356.
8. Office for National Statistics. Available at www.ons.gov.uk/ons/index.html.
9. Sehat KR, Bannister GC. The prevalence of established scaphoid fracture non-union found on incidental radiography. Int. J. Care. 2000; 31(4):275-6.

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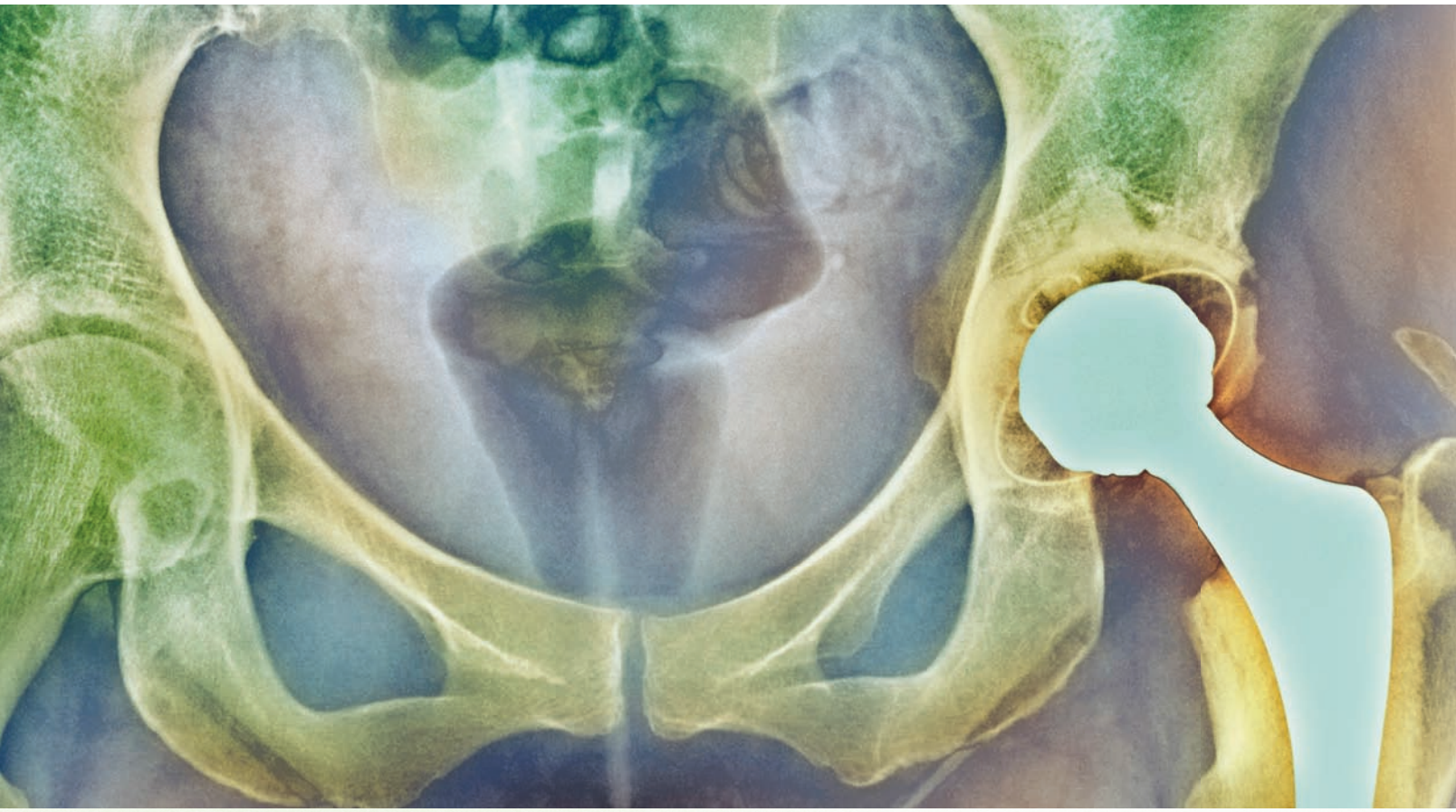

MEDICAL IMPLANTS AND THE MR ENVIRONMENT: A CHANGING LANDSCAPE

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

Since the advent of clinical MR, exclusion of ferrous and/or conducting devices from the MR environment has been a key tenant of maintaining patient safety. To this day, patients with conductive (e.g. metallic) implants are, in general, contraindicated for MR scans. Among the concerns associated with metallic implants are displacement forces, torque, RF heating, and image artifacts. However, ongoing advances in biomedical engineering have enabled a variety of devices, including implants, to function safely within specified MR environments. These devices include vascular stents, orthopedic components, and cardiac defibrillators.

In order to facilitate safe MR scanning of patients with appropriate implants, the US Food and Drug Administration (FDA) Center for Devices and Radiological Health (CDRH) requested that ASTM (American Society for Testing and Materials, now known as ASTM International) develop language and guidance to address this topic. This resulted in the formation of the ASTM task group F04.15.11 on the safety and compatibility of implant materials and medical devices in the MR environment.[1, 2]

The ASTM MR task group developed a set of testing standards as well as terms and icons[3], which allow classification of a given implant into one of three categories (see Table 1).

	Devices labeled as MR safe must pose no known hazards in all MR imaging environments. These include devices which are non-conducting, non-metallic, and non-magnetic. For patients with implants that are labeled as MR safe, consult the implantable device's labeling.
	Devices labeled as MR conditional must pose no known hazards in specified MR environments complying with specified conditions of use as determined by the device manufacturer. For patients with implants that are labeled as MR conditional, consult the implantable device's labeling.
	Devices labeled as MR unsafe are known to pose hazards in all MR environments. These include magnetic items such as a pair of ferromagnetic scissors. Patients with implantable devices that are labeled as MR unsafe are contraindicated against entering the MR environment.

Table 1. Classification of a given implant.

In context of ASTM guidance, implants labeled as MR safe or MR unsafe enable a relatively straightforward approach to patient safety. A more complex approach is required for safe scanning of patients with implantable devices labeled by their manufacturer as MR conditional. It is essential to understand what specific operating conditions these implants may be introduced and scanned in the MR environment. When evaluating whether to proceed with MR scanning on patients with such implants, consult the implantable device's labeling.

The safety profile of a scan may change depending on the type of scanner, scanner settings, pulse sequence, and even a patient's physical location within the MR environment. Examples of MR conditional specifications include, but are not limited to: maximum static magnetic field strength; maximum spatial gradient; maximum time rate of change of the magnetic field (dB/dt); and, specific absorption rate limit. Additional specified conditions may include limits on the control mode, patient positioning, scan time, and coil selection. For example, applying Preset or Optimized RF Drive Modes or utilizing a transmit coil may violate the MR conditional specifications of a given implant. A comprehensive understanding of both the MR system and implant labeling is essential to facilitating the safety of a given scan.

GE Healthcare is committed to enabling a safe and effective MR scanning environment. Our MR system documentation will be revised to provide clinicians with both updated guidance on interpreting device labeling as well as MR system specifications to consider before and during MR scanning.

The topic of scanning patients with medical implants within the MR environment is complex and will certainly continue to evolve both from a technological as well as a guideline perspective. In partnership with industry, clinical, and regulatory organizations, GE Healthcare will continue to advance both the science and processes of MR safety.

References

1. Woods, T. (2007), Standards for medical devices in MRI: Present and future. J. Magn. Reson. Imaging, 26:1186–1189. DOI: 10.1002/jmri.21140.
2. Woods, T. (2008). Establishing Safety and Compatibility of Passive Implants in the Magnetic Resonance (MR) Environment. Food and Drug Administration Center for Devices and Radiological Health.
3. ASTM Standard F2503-08, "Standard Practice for Marking Medical Devices and Other Items for Safety in the Magnetic Resonance Environment", ASTM International, West Conshohocken, PA, 2008, DOI: 10.1520/F2503-08, www.astm.org.

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GE MR SYSTEMS SCAN ATHLETES AT LONDON OLYMPIC GAMES

During the 2012 Olympic Games in London, MR imaging was solely provided by GE Healthcare. Physicians used two wide bore systems, a Discovery* MR750w 3.0T and an Optima* MR450w 1.5T with the GEM Suite of coils, to help diagnose and monitor athlete injuries.

The MR systems, housed at the new, four-story Polyclinic located in the Athletes' Village in Olympic Park, offered Olympic and Paralympic athletes—as well as team officials—access to exceptional image quality and a more personalized MR experience.

MR: a major player

Estimates show that the Polyclinic carried out more than 1,600 examinations (twice the number of scans as the Beijing Olympics Games in 2008), of which 900 were MRI, 259 were x-ray, 400 were ultrasound, and 58 were CT. GE Healthcare staffers—including application specialists and engineers—were on site from 7 a.m. to 11 p.m. "It was very busy in the Polyclinic... 52 MRIs were performed on a single day," comments Finn Crotty, GE Healthcare's London 2012 Project Lead. "Having access to two of our MR systems onsite was critical."

Peggy Ferguson, Global Advanced Application Specialist at GE Healthcare, took shifts in the Polyclinic—assisting

The Polyclinic, located in the Athletes' Village in Olympic Park, was home to a Discovery MR750w 3.0T and an Optima MR450w 1.5T with the GEM Suite of coils. The MR systems were housed inside the trailers.

Athletes entered here, in front of the Polyclinic, to await their MR scan on the Discovery MR750w 3.0T.

Olympic technicians inside the Optima MR450w 1.5T scan room took a break between scanning patients.

technicians and assuring that the MR systems were always scanning in tip-top form. "The work was intense. Usage was prioritized and the scanners were heavily utilized," offers Ferguson. "Both MR systems provided exceptional care to the athletes… mainly for MSK injuries, but also for head and spine."

Precise information

According to Bryan Mock, Global 3.0T Product Manager for GE Healthcare, the new wide bore scanners have a proven track record when it comes to the assessment of musculoskeletal injury by providing excellent image contrast and resolution. As a result, Olympic athletes and their doctors were provided with precise information that evaluated injuries, and helped determine if an athlete could continue to compete.

"These new wide bore systems boast high-performance and flexible coils for capturing precise images of shoulders, knees, wrists, elbows, and other body parts to identify injuries—whether muscular or skeletal," says Mock. "The scanners are also ideal for neurological exams in cases where an athlete may have sustained a head or spinal injury during competition."

A more personal experience

The Discovery MR750w and Optima MR450w were excellent choices for the Polyclinic based on the theory that a relaxed patient yields more accurate images. The scanners' wide bores help make the MR exam more comfortable and less intimidating—especially for those who have claustrophobia issues—and easily accommodate athletes' broad chests and shoulders. Both systems also offer the option to enter feet first, as well as a table surface with ergonomically designed cushioning and lightweight coils that adapt to all sizes.

Bettina Fitt, GE Healthcare's Country Manager for UK & Ireland, said that the Polyclinic (including the two GE MR systems) helped treatment to be more personalized, and timing for return to the competition arena was more accurately predicted. "This personalization provided athletes with an edge in competition, as very small measurements can separate gold from silver medals."

Ferguson concurs. For example, three athletes requiring scans enjoyed quick return to play as a result of the speedy and highly accurate diagnostic process, with one treated athlete returning to competition after an MRI even winning a gold medal!

The not-so-final lap

The London Olympics may be over, but because the GE MR systems used in the Polyclinic have found permanent homes in England, they continue to offer exceptional image quality and a more personalized MR experience. Additionally, the Games have provided GE Healthcare with new, important insights regarding its commitment to humanizing MR.

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GE Healthcare's Peggy Ferguson, who took shifts in the Polyclinic—assisting technicians and assuring that the MR systems were always scanning in tip-top form—enjoyed the view from the Olympic Rings. Behind her is the Olympic Village where the athletes stayed.

Images courtesy of Peggy Ferguson, GE Healthcare.

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