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PHILIPS

MRI Magazine

FieldStrength

Innovation for you. Innovation **with you.**

MRI of patients with MR Conditional implants

Relaxed patients, reduced motion, improved productivity

Running a successful MRI business

Approaches to integrate MRI into radiation therapy planning

Dear Friends,

At Philips, we believe that MR can touch far more lives than it does today. We focus our innovations on contributing to delivering better care at a lower cost and put the patient at the center. Our solutions are designed to create value for our customers. We think that collaboration with you, our customers and partners, is critical to drive new value in MRI, to the benefit of all stakeholders.

At ISMRM 2016 we showed our range of Open Innovation tools, designed to give you the flexibility you need to realize your ideas and to accelerate your innovation. With our flexible user interface, the Paradise pulse sequence programming environment, our Recon 2.0 image reconstructor, and image processing with the research tools of IntelliSpace Portal Discovery, we provide you with access to our systems to aid you in advancing your MR research.

This issue of FieldStrength provides you with articles on interesting trends in MRI. You can read about the rapidly increasing need to scan patients with MR Conditional implants and expert views on how to respond to that. Discover the relations between possible financial benefits, reducing motion artifacts and improving patient MRI experience. UMC Utrecht shares their approaches for the integration of MRI into radiation therapy planning. And there is much more!

We look forward to exchanging ideas with you at the next occasions that we meet.

Enjoy reading!

Marc van Cauteren
Director MR Clinical Science Asia Pacific, Philips Healthcare

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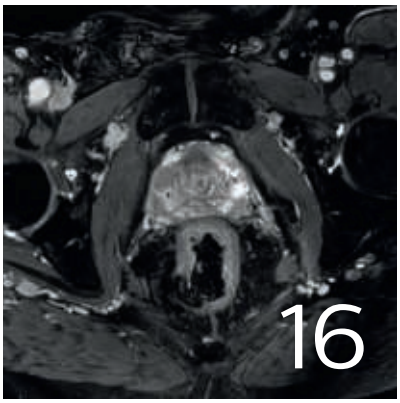
MR Safe 6



Trends in MRI

User experiences

News

Touching more lives with MR

Recent innovations aim to make MR more accessible, more definitive and expand into treatment guidance

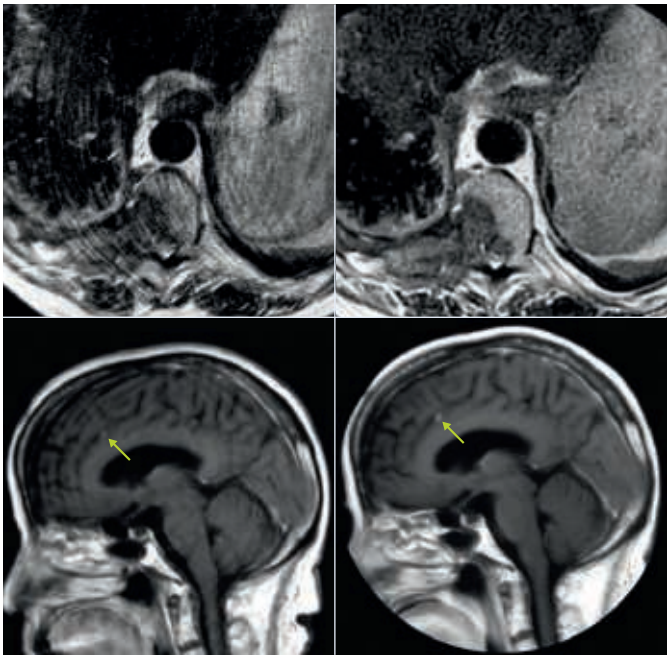
MRI is universally acknowledged as a diagnostic imaging modality with excellent capabilities, bringing superb clinical results, helping the radiologist and referring physician's diagnostic confidence. Yet it is often considered expensive, with elaborate setup and lengthy exams, which is why it is often not used as initial imaging method. Our ambition is to touch more lives with MR, so that when MR is the best choice for patients, it is also an easy choice operationally and economically.

High value MR

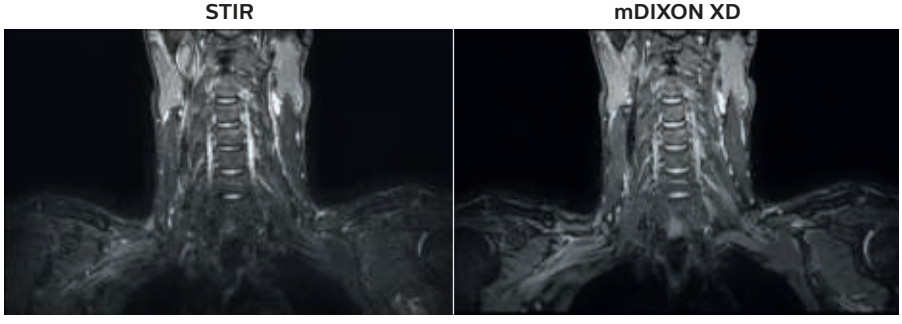
Our vision dovetails nicely with the ISMRM Value Initiative, which describes its goal as "to increase the robustness of MR in the context of changing healthcare economics." With our innovations focused on expanding the use of MR we believe we are in the right position to contribute to the development of high value MR.

More diagnostic information in the available timeslot

High image quality is essential to fulfilling our vision. Today, incomplete fat suppression can be history with mDIXON XD, which also allows you to obtain multiple contrasts from just one scan. It now even enables subtractionless multistation MR angiography exams. Furthermore, it can be combined with MultiVane XD for high resolution, fat-free diagnostic images even in cases of severe patient motion.



Ingenia 1.5T. Spine: T2W TSE, 1:20 min. Brain T1 FLAIR TSE, 2:40 min.



Ingenia 3.0T, voxels 0.9 x 1.2 x 3.0 mm
STIR 4:46 min. mDIXON 3:46 min.

Enhancing workflow for efficient exams and predictable scheduling

We focus on providing an exceptional patient and user experience. Our patient in-bore experience solution aims to help relax patients during scanning to support fast and robust imaging. It especially benefits patients who may have avoided MR imaging.

We also designed ScanWise Implant to make it easier to scan patients with MR Conditional implants, and in the hope that it will help to reduce the number of patients who are unnecessarily denied MRI because of these implants.

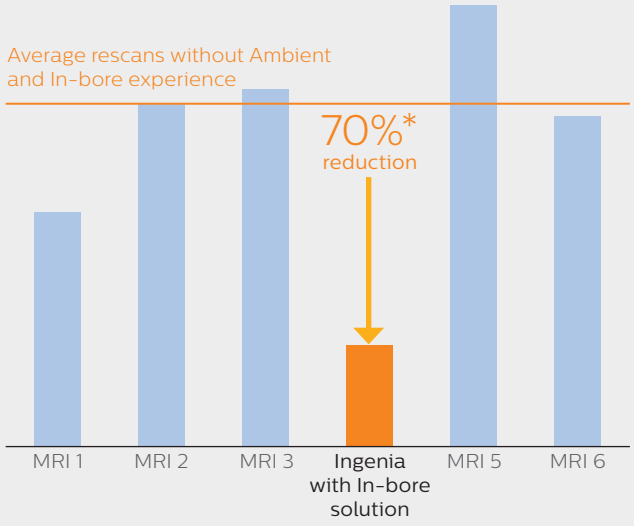
Increase diagnostic value through quantitative and other advanced techniques

Our advanced and quantitative techniques, such as mDIXON Quant, ADC maps, MRE and CardiacQuant, can help increase MR's diagnostic value. Advanced visualization and analysis through IntelliSpace Portal can add to the diagnostic value of MR, by providing tools such as tumor tracking and multimodality fusion, among many others.

Expand the use of MR into therapy guidance

MR-guided procedures, including MR biopsy guidance, MR brachytherapy, MR-OR and MR-RT, extend the value of MR to new areas. For example, using MR in combination with, or instead of CT, adds the benefits of high soft tissue contrast in radiation therapy planning for oncology patients. «

Number of interrupted scans in a year in the six scanning rooms
Courtesy of Herlev Hospital, Denmark



*Compared to the average of the other 5 MR scanners without Ambient and in-bore experience. Results from case studies are not predictive of results in other cases. Results in other cases may vary

Innovation for you. Innovation with you.

Imagine a future where MR is optimized to help radiologists give a quick definitive answer to a specific clinical question. Together with you, we're on the path to make MR more informative and more accessible – and expanding its reach beyond diagnosis to MR-guided approaches in therapy.

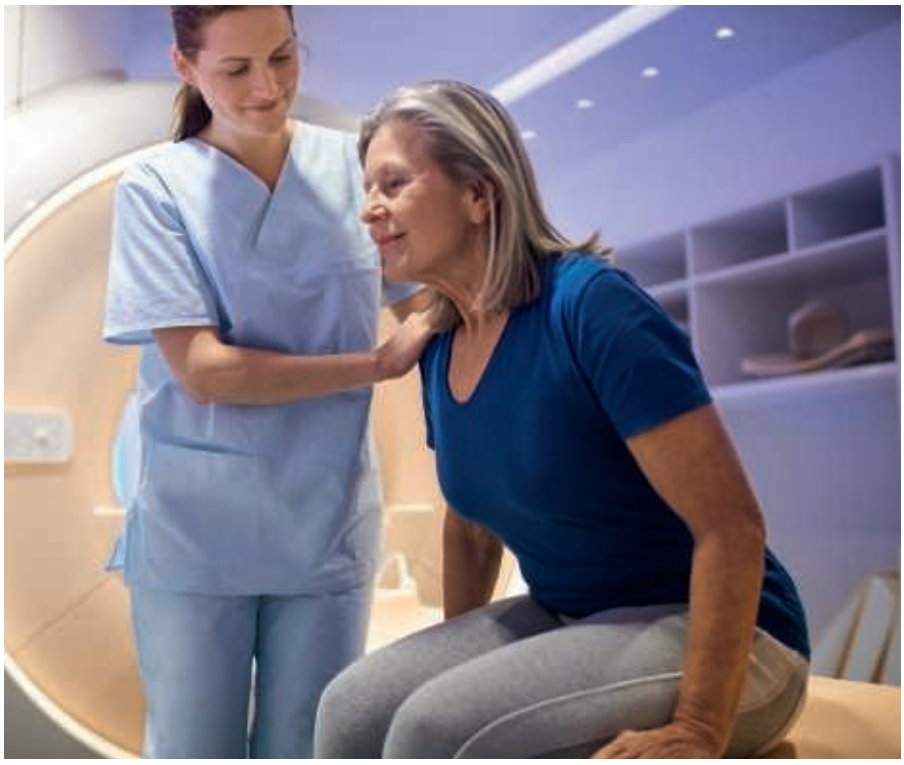
As we've expanded what MR can do, we have also built a community, based on our open innovation platform, and a belief that colleagues aren't limited to those who work in the same place, but include all who pursue similar goals.

Do you have a vision about how we can touch more lives with MR? We'd love to hear your ideas. And to learn more about our innovations and to view cases, visit www.philips.com/ISMRM.

Scanning patients with **MR Conditional implants**

Clearly specified conditions are key

12.5 million people in the USA are presently carrying an orthopedic or cardiac implant



With an aging population, large joint replacements and cardiac implantable devices are becoming increasingly prevalent. Also the prevalence of conditions needing an MRI examination, such as neurodegenerative diseases, cancer, and musculoskeletal diseases, increases with age.

"There are only few implants for which scanning is an absolute contraindication"

Not all implanted devices are an absolute contraindication for MRI anymore. Patients with MR Conditional implants can undergo MRI, but only under clearly defined conditions and performed by well-trained MRI staff. In this article, four MRI experts discuss the scanning of patients with MR Conditional implants. But first of all, how relevant is this topic?

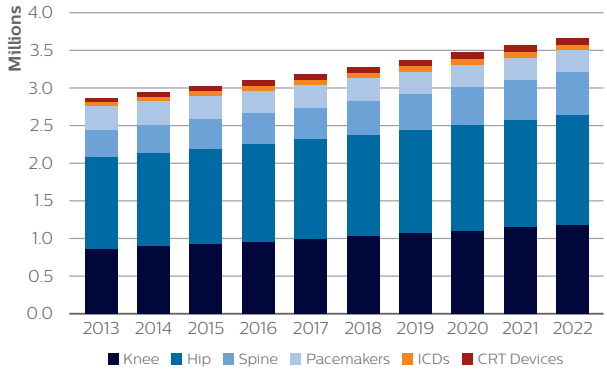
Metallic and electronic implants are on the rise

In five major European countries (France, Germany, Italy, Spain, and the UK) more than 2.5 million large joint reconstructions and spinal implant procedures were performed in 2015, a figure expected to rise to more than 3 million in 2020 [1].

In those same countries, the prevalence of such passive orthopedic implants was 19% among people over the age of 65 years, which is predicted to rise to 30.5% in 2020 [1]. The prevalence of active cardiac implants is also expected to rise from the current 10.4% in the over 65 population to 11.8% in 2020.

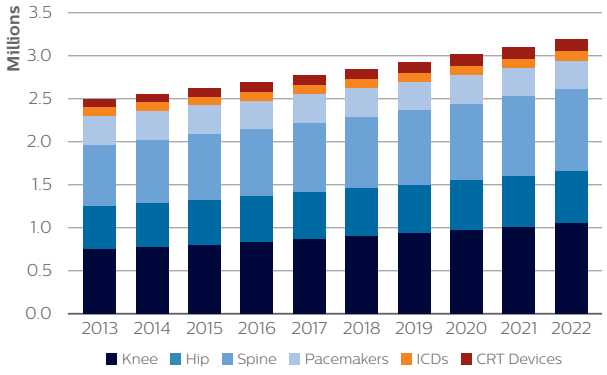
A similar situation is seen in the USA, where 17% of the over 65 population are estimated to carry a large joint or spinal implant and 10.4% have a cardiac implant, figures predicted to rise to 26% and 11.8%, respectively, by 2020 [1]. »

Orthopedic and cardiac implants in Europe



	2015	2020
# Procedures	> 3 M	> 3.4 M
Total population	321 M	326 M
% with implant	3.9%	7.2%
Total 65+	63 M	68 M
% 65+ with implant	13.3%	28%

Orthopedic and cardiac implants in USA



	2015	2020
# Procedures	> 2.6 M	> 3.1 M
Total population	322 M	345 M
% with implant	3.1%	5.6%
Total 65+	48 M	56 M
% 65+ with implant	21.6%	31.3%

Emanuel Kanal, MD, FACR, FISMRM, AANG, Professor of Radiology and Neuroradiology and Director of Magnetic Resonance Services at the University of Pittsburgh, Pittsburgh, USA. He is Chairman of the American Board of Magnetic Resonance Safety and is lead author of the American College of Radiology's White Paper on MR Safety and MR Safe Practice Guidelines.

Greg Brown, MRI Consultant and PhD candidate at the Centre for Advanced Imaging, The University of Queensland, St Lucia, Australia. He is an Honorary member of the SMRT, and serves on their MR safety group. He is a non-voting Board Member and SMRT delegate on the American Board of Magnetic Resonance Safety, and holds their MRSO certification. Mr. Brown is an active user of social media platforms on the use of MRI and MRI safety.

Paul W. de Bruin, PhD, Medical Physicist at the Radiology Department, Leiden University Medical Center, Leiden, Netherlands. As a member of the Clinical Physics Group and the C.J. Gorter Center for High-field MRI at Leiden University, he has various research interests in the field of MRI including high-field MR (3T/7T) applications, DCE-MRI, sodium MRI, pharmacokinetics, and musculoskeletal applications.

Harald Kugel, PhD, MR Physicist at the Department of Clinical Radiology of the University of Münster, Münster, Germany. He is the author of numerous articles on MR applications and safety, has been actively involved in the teaching of practical ISMRM courses in MR safety, and is a member of the Technical Committee 'MR Procedures' of the German Standards Committee Radiology.

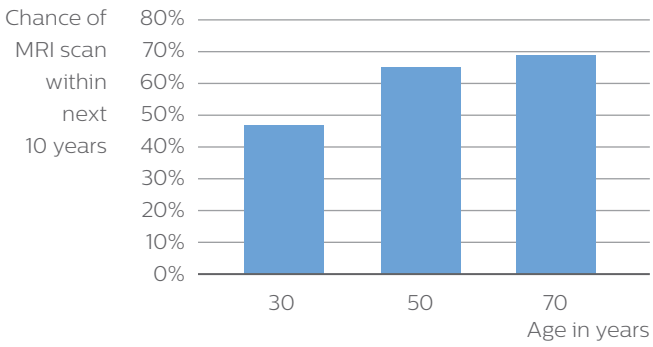
"Scanning patients with MR Conditional implants inevitably brings its own challenges"

Patients with implants often need MRI scans

There is a significant clinical need for patients with orthopedic implants to undergo MRI examinations. Besides the increased prevalence of medical implants in older people, the likelihood that the average person will need an MRI scan during the next 10 years increases with age from around 47% at the age of 30, to around 69% at the age of 70. [1]

Combining these numbers with the data on implant incidence suggests that, for instance, in the USA, 5.7 million patients over 65 and carrying orthopedic or cardiac implants will need an MRI scan within 10 years. And this will rapidly rise to about 12.6 million patients in 2020, a doubling of the number in five years.

A recent USA-based study of patients with spinal cord stimulation (SCS) implants estimated that about 82–84% of SCS-implanted patients will need a spinal MRI scan within 5 years of receiving their SCS implant. A further 59–74% of patients will need a non-spinal MRI scan within 10 years [2].



Which patients with implants can be scanned?

There are currently above 34 million MRI patient exams per year within the USA [3]. About 3.9% of the US population – 12.5 million people of whom 10.3 million are over 65 – are presently carrying an orthopedic or cardiac implant. Due to safety concerns, patients carrying some kind of metallic medical implant or device may potentially be denied an MRI scan. But are such concerns justified?

"There are only few implants for which scanning is an absolute contraindication, but we can scan patients with an MR Safe or MR Conditional implant," says Emanuel Kanal, MD, Director of Magnetic Resonance Services and Professor of Radiology and Neuroradiology at the University of Pittsburgh Medical Center, USA. As Dr. Kanal explains, many patients who are referred for an MRI scan have an implant of some kind. "At an academic center the chances of a patient having an implant are much higher than in a free-standing, private practice environment. I would guestimate that at our site the number of patients with implants is somewhere between 10% and 25%."

According to Greg Brown, MRI technologist studying at the Centre for Advanced Imaging, University of Queensland, Australia, a similar situation exists in his country.

Understanding implant types and scanning conditions: MR Safe, MR Conditional, MR Unsafe

"There may be certain devices or implants that at certain levels of radiofrequency power may be potentially dangerous to scan," says Dr. Kanal. Such implants may interfere with the MRI-related RF fields inside the body, resulting in increased risks to the patient due to local hot spots.

"An MR Safe implant has no potential interaction with a scanner," says Mr. Brown. "So that would be non-conducting, non-magnetic objects. But other implants have the label 'MR Conditional' and that term is really quite important."

Definitions and icons*

MR Safe

An item that poses no known hazards resulting from exposure to any MR environment. MR Safe items are composed of materials that are electrically nonconductive, nonmetallic, and nonmagnetic.

MR Conditional

An item with demonstrated safety in the MR environment within defined conditions. At a minimum, address the conditions of the static magnetic field, the switched gradient magnetic field and the radiofrequency fields. Additional conditions, including specific configurations of the item, may be required.

MR Unsafe

An item which poses unacceptable risks to the patient, medical staff or other persons within the MR environment.

*Reprinted, with permission, from ASTM F2503-13 Standard Practice for Marking Medical Devices and Other Items for Safety in the Magnetic Resonance Environment, copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM, www.astm.org.

All medical implants have to be tested by their manufacturers for MR safety and labeled according to standardized terminology [4].

Active implants are those that contain a power source (such as cardiac pacemakers and spinal cord stimulators), whereas passive implants have no power source (such as aneurysm clips and replacement joints).

Are patients unnecessarily denied scans?

Although comprehensive guidelines for the safe use of MRI have been issued by professional bodies such as the American College of Radiology (ACR) [5] and Medicines and Healthcare Products Regulatory Agency [6], some confusion remains in everyday practice. "As a result, patients with implants who need an MRI scan may be either never referred or are denied the scan; this is very much dependent on the site," Mr. Brown explains.

"Patients with implants are denied MRI scans by some places. But as a major hospital site, we might be looking at just a couple of patients that we really can't scan, maybe 1-2%. At a site where they are not as comfortable with the safety aspects or don't want to spend the time on it, they might be rejecting more."

"The lack of awareness by referring physicians and even radiology experts can be problematic," says Dr. Kanal. "Many times people tell us they didn't even bother sending their patients with conditional implants for an MRI. Instead, they sent them straight for a CT, thinking they could not get safely scanned on MRI."

Radiology should lead in changing perceptions

"I think there is a lack of understanding among radiologists and technologists, let alone referring physicians," says Dr. Kanal. "But I don't believe it is the referring physicians' responsibility. I think it is the responsibility of radiology to educate them and to explain that we can perform an MRI on a certain patient by scanning under certain specific conditions."

"Blanket rules, like not scanning pacemakers, are not serving the patients very well"

"The perception that all active implants, such as pacemakers cannot be scanned, is also incorrect," says Mr. Brown. "This may still refer back to old guidance coming from early practice. The British Heart Rhythm Society has just released guidelines for scanning MR Conditional pacemakers [7]. And there has been a 2015 German publication on the same topic [8]. Both are trying to say that we need to think more about this, because the patients are going to need these scans. So blanket rules, like not scanning pacemakers, are not serving the patients very well."

Finding the conditions before scanning

"Scanning patients with MR Conditional implants inevitably brings its own challenges," explains Paul W. de Bruin, PhD, medical physicist in the Radiology Department at Leiden University Medical Center, the Netherlands. "It involves two steps that cost us time. The first one is figuring out exactly which implant the patient has. That could be improved by having some sort of registry to look up which implant is in the patient. The second is that it can sometimes be difficult to find the information from the implant manufacturer. For instance, when we find that a certain implant is labeled MR Conditional, it means that we can scan under certain conditions. We then have to figure out what those conditions are by going to the implant manufacturer's website. But it's often not straightforward to find the information. After that we need to pay special attention when we bring the patient to the scanner and when setting the sequence parameters at the scanner to remain within the condition limits throughout the exam."

These suggestions are reinforced by Mr. Brown. "The means to rapidly identify the exact device in a patient would help MR sites. A central internet-accessible repository by manufacturers of the instructions for use and MR conditions available for all their devices, including ones no longer sold, would speed things up a lot for sites."

Setting up MRI scans for patients with MR Conditional implants

"Scanning patients with implants means having to be aware of the possible hazards," says Harald Kugel, PhD, MR physicist at the Institute of Clinical Radiology, University of Münster, Münster, Germany. "There are specific limits on specific parameters. One of the most common limits is on specific absorption rate (SAR) [9]. In general, this means that spin echo and TSE sequences should be avoided by switching to gradient echo instead. This is just an example of what needs to be done or considered."

"We have specific standard operating procedures, telling our staff what to do with specific implants. For common implants everybody in our team knows what to do. For instance, if a patient with a pacemaker comes for an MRI exam, we have a specific routine to check which type of pacemaker it is, »

"Scanning patients with implants means having to be aware of the possible hazards"

to check that a cardiologist is present as an MR Conditional pacemaker usually needs to be switched in an MR-compatible mode, etc. So some actions have to be taken and this is all laid down in our procedure."

Education is an important step

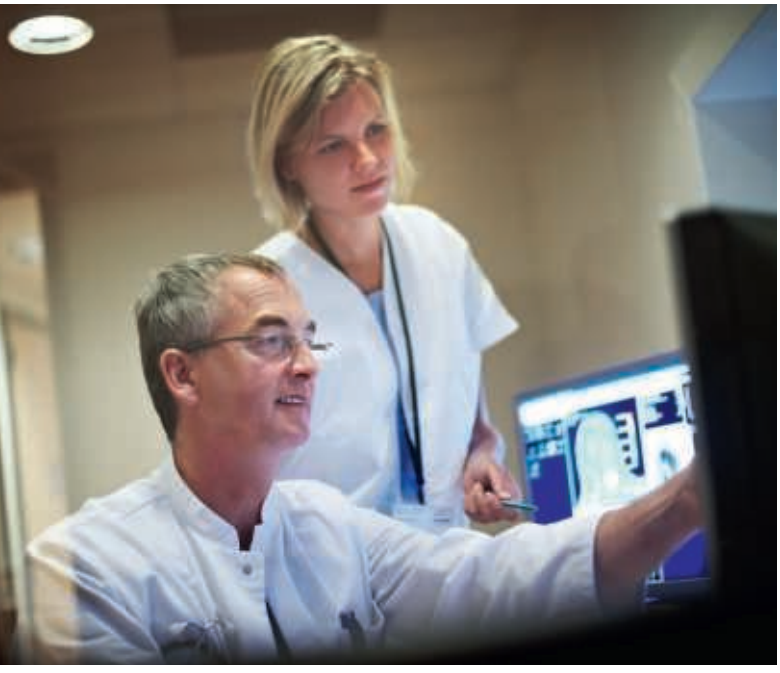
"I think a lot more education of technologists and radiologists is needed, so that we can develop an efficient and structured way forward," Mr. Brown says.

"We know that MRI scanners have to pass certain levels of safety and show that they are documented to be kept at certain guidelines and thresholds [10]. MR site accreditation in the USA [11] documents that the site is appropriately designed," says Dr. Kanal. "But who is missing in all this? There was no certification process to show that the magnetic resonance medical director, radiologist, technologist, or physicist have a comprehensive understanding of the safety issues associated with magnetic resonance environments or how to apply them. We therefore created the American Board of MR Safety in 2014. Its sole purpose is to certify and credential MR medical directors, MR safety officers, and MR safety experts, who represent the radiologists/physicians, technologists, and physicists who are charged with overseeing safety in clinical and research magnetic resonance environments."

Saying 'no' is easy, but saying 'yes' requires knowledge

"Sometimes patients have certain implants and the site is not sufficiently familiar with what can and can't be done to decrease the risk of an MRI scan," says Dr. Kanal. "They may choose, for ostensible 'safety' objectives, to not scan that patient. I put the word safety in quotes because not scanning a patient for whom a diagnostic MRI was requested has its own risks. The patient may go undiagnosed or may have to be sent for a more invasive study to make a diagnosis."

"Saying 'no' is easy, but saying 'yes' requires knowledge, confidence in that knowledge, and the willingness to say yes and to apply that knowledge." «



"Not scanning a patient for whom a diagnostic MRI was requested can also potentially impact patient care"

References

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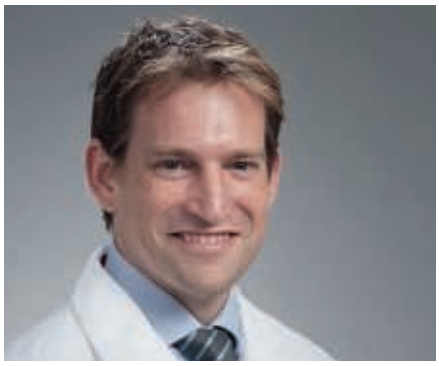
11. American College of Radiology. *Accreditation.*

Relaxed **patients**, reduced **motion**, improved **productivity**

Can improving MRI patient experience help to reduce motion artifacts and repeated sequences and thus have a financial benefit?

MRI motion artifacts are calculated to lead to revenue loss for the healthcare provider. As more relaxed patients are less likely to move during an MRI scan, can improving the MRI experience help to reduce motion artifacts?

Adopting a holistic approach, aiming to improve the whole trajectory of the patient's MRI experience, may be key to improving patient satisfaction. It may also reduce motion and thus have a financial benefit. »



Jalal B. Andre, MD, DABR®, is Director of neurological MRI and MRI safety officer at Harborview Medical Center, Seattle, Washington, USA, and Assistant Professor of Radiology at the University of Washington School of Medicine, Washington, USA. He has several areas of expertise, including the clinical application of advanced MRI techniques in assessing brain vessel abnormalities and traumatic brain injuries.

Katarina Johansson is Radiology Nurse at the Astrid Lindgren Children's Hospital, Stockholm, Sweden. She has particular expertise in the application of MRI for pediatric patients.

Anxious patients are more likely to move

Undergoing an MRI examination can be an intimidating experience for patients, causing feelings of fear and anxiety, and creating a sense of reduced self-control. [1] Anxiety reactions, including increased heart rate and blood pressure, have been reported in up to 30% of patients undergoing MRI scans. [2] Specifically, entering the bore of an MRI scanner can be associated with anxiety reactions, with patients reporting feelings of abandonment or disorientation. [2] This emotional discomfort can increase the likelihood that a patient will move while in the scanner bore, resulting in motion artifacts which may blur image interpretation or even lead to retakes or aborted exams. [3]

Lost revenue due to patient motion leading to repeat scans

"We investigated the prevalence of patient motion in MRI about two years ago to try and quantify how often motion is occurring and when it's occurring," says Dr. Jalal B. Andre, Assistant Professor of Radiology at the University of Washington School of Medicine. The study involved a retrospective review of scans conducted at a single institution, using three different MRI scanners, during a period of one week. [4] "Our study identified significant motion artifacts in almost 7.5% of outpatient MRI scans and nearly 30% of MRI scans performed in the inpatient and/or emergency department settings."

In Dr. Andre's study, motion artifacts were identified as the cause of repeated sequences in about 20% of MRI exams. Recent institutional data were used to compute a cost estimate, which was correlated with sequence time and severity of motion artifacts. "We calculated the financial consequence of repeat sequences due to motion artifacts to be about 115,000 US dollars of lost potential revenue per scanner per year." [4]

Moreover, the repeated sequences can also create a cascade effect, resulting in increasing delays throughout the day and decreased patient throughput. "In addition, reducing or avoiding motion artifacts in MRI images can result in improved diagnostic confidence for the radiologists interpreting these studies, and aid them in formulating their diagnoses," says Dr. Andre.

"We calculated that motion artifacts could lead to about 115,000 US dollars of lost potential revenue per scanner per year"

20%

of scans with **motion artifacts** that caused **repeated sequences**

115,000

US dollars per scanner per year
Lost potential revenue due to **motion artifacts**

"Using such approaches to comfort patients and help them relax can have a positive effect on the patient experience"

Holistic approach can enhance the MRI experience

"I think it's going to become more obvious as time goes on, that the MRI environment is fairly foreign to many patients, and that some factors related to the patient's experience are important to identify in treating the patient as a human being. Ultimately, we want to mitigate the motion associated with these factors," says Dr. Andre.

It is not just lying in the MRI scanner, or even being in the scanner room, that influences the MRI patient's experience. Also preparation for the scan, scheduling the appointment, the stay in the waiting room and other factors contribute to it. This is why adopting a holistic approach toward making patients as comfortable as possible during their total MRI experience may be key to mitigating patient motion and its potential consequences.

According to Dr. Andre, undergoing an MRI exam as a patient can provide valuable lessons for a radiologist. "I was recently in an emergency and experienced having to undergo an MRI exam as a patient. Although I've previously undergone several MRIs as a volunteer subject, I had never been subjected to one while in acute pain. That was a very different experience and it really affected me. I imagine that the higher a pain score a patient reports prior to MRI, the more likely she/he is to move during the exam."

Design the environment to enhance the patient's MRI experience

During the past decade there has been considerable attention on the in-room experience of patients undergoing MRI scans. As Dr. Andre says, "Changes have been made to the room and the lighting, intended to make people feel comfortable – just creating an overall ambience within the room that attempts to invite and relax the patient. I think the overall feeling is that everyone is aware of the need to comfort patients and they are trying to make improvements."

"Using such approaches to comfort patients and help them relax can have a positive effect on the patient experience," explains Dr. Andre. "At RSNA 2015 I saw a fantastic implementation of the system that Philips is using aimed at making the patient comfortable while in the bore: placing a monitor at the back side of the scanner, and using a mirror to redirect the image to the patient's eyes. So the patient can watch what's on the screen while lying in the scanner. I think that can be very helpful."

Herlev Gentofte University Hospital (Denmark) designed their scanner environment and implemented Ambient and audiovisual in-bore experience to improve their patients' MRI experience. Their efforts helped them reduce patient motion and increase efficiency. [5] In a recent case study at Herlev hospital they reported 70% reduction in rescans with MR Ambient and audiovisual in-bore experience.*

"An engaging environment is particularly important for pediatric patients undergoing MRI scans," says Mrs. Katarina Johansson, a Radiology Nurse at the Astrid Lindgren Children's Hospital, Stockholm, Sweden. "We have dynamic lighting, projection and sound switched on as the child walks into the room. The light is very relaxing. Older children often tell us, 'This is awesome, it's not like I thought it would be'. When the children walk into the room with this really nice atmosphere, you easily win their confidence."

Transforming the in-bore MRI experience

Many methods have been explored and implemented to alleviate the MRI experience in the bore – for the sake of the patient as well as for reducing motion artifacts and retakes, benefitting department efficiency and the diagnostic confidence of the radiologist interpreting the images.

During an MRI scan, when being alone in the bore, a patient needs to lie still throughout the exam. An exam can often take 30 minutes or more. At the same time, the MRI exam can be associated with loud noises, and often the patient is additionally asked to hold their breath for some time.

An MR vendor can design the MR system, coils and accessories to enhance patient comfort during the exam. For distraction the patient can be allowed to listen to music or even undergo an audiovisual experience with an in-bore solution that provides visuals and sound. »

*Compared to the average number of rescans with the other 5 MR scanners without Ambient and in-bore experience. Results from case studies are not predictive of results in other cases. Results in other cases may vary.

"We try to make it a fun experience for the children"

Scan methods to mitigate or decrease the noise of the scan are available. Quieter technologies can attenuate the noise levels that many patients find distressing while undergoing MRI scans.

Countering motion with scan techniques

For many patients, and especially children and elderly, holding their breath during an MRI scan can be problematic. This can be made easier by speeding up scans to make breath-holding times shorter, or by developing scan sequences that are compatible with free breathing.

"There are available techniques like navigator echoes that can mitigate breathing motion. Depending on who you ask and how efficient the navigator is, it can have a relative effect on image quality," says Dr. Andre.

"Prospective optical tracking systems are also in use to correct for motion. [6] I think these systems will have an added bonus in the long run because people don't want to be strapped in; they want to be free to move a little bit and let the motion tracking system do the rest."

Robust motion reduction methods based on data collection in concentric vanes are available to reduce motion artifacts in images when motion did occur during the scan.

Playful preparation for pediatric patients

There are indications that careful patient preparation may help reduce patient anxiety. Using a DVD with information to prepare patients for MRI scans [7,8] was shown to help patients feel less anxious during the scan and significantly reduce motion artifacts.

Many pediatric patients undergoing MRI require general anesthesia due to difficulties in remaining still for the length of the procedure. [9] The use of technology, such as audiovisual interventions, to distract pediatric patients has been shown to significantly reduce the need for sedation, and its associated risks to the patient. [9,10]

"Simply visiting a hospital can be an almost overwhelming experience for children, and especially for younger children who need to undergo a procedure without a parent present," says Mrs. Johansson. "Ensuring a positive experience for children undergoing MRI scans brings its own particular set of challenges. Careful preparation is crucially important. If it is the first time a child is to be scanned, we ask them to come maybe one week earlier, just to say hello to us and to see the MRI scanner."

The Astrid Lindgren Children's hospital uses a play-scale model of an MRI scanner (KittenScanner) to help children become familiarized with the scanning procedure using toy characters. "We use an MRI room with Ambient Experience that was developed to reduce patient anxiety. We choose a theme that fits the age of the child," says Mrs. Johansson. "The child enters a room that is not much like a hospital, but has round corners and the theme's nice atmosphere. The child then tries to lie on the MRI table and go into the bore. I explain to them that they will listen to music and will meet their favorite character from the KittenScanner when they return. We try to make it a fun experience for the children instead of a scary one."

Long exam window more likely to satisfy patients

Delays due to repeat scans, and interruptions due to emergencies, can negatively impact the patient's experience prior to the MRI scan itself. According to Dr. Andre, reducing patient frustration caused by delays can have real benefits.

"For example, if a patient – who needs a 45-minute scan – is given a two-hour window instead of a fixed time, that buys us a little time in case an emergency comes up. That's one way of establishing expectations early on for the patient. If the patient perceives that we are respecting their time, then they are more likely to be satisfied. If our patients are happier at the start, they are less likely to move. I think just making some changes to the way we are scheduling could help mitigate motion to some extent."

"I imagine that patients feel that – regardless of what we attempt to do – scans are currently far too long in duration, and certainly longer than they expected," says Dr. Andre.

"If our patients are happier at the start, they are less likely to move"

Does the Affordable Care Act drive improvements?

"We send out patient surveys, while other surveys are done on-site to collect data on how satisfied our patients are. It reminds everybody how important it is that the patient is having a positive experience in the hospital, and helps define exactly what that experience is. If it helps us identify some simple changes that we can implement to make the experience better for people, I think that is a valuable goal."

Patient satisfaction is increasingly being viewed as a major indicator of the quality of healthcare. [11] When the Affordable Care Act took effect in the USA, changes in reimbursement were introduced whereby some part of payment to hospitals is linked to patient satisfaction scores. [12] A key motivation behind this was the desire to improve the quality of care by gaining feedback from patients.

"We hold monthly meetings in which we discuss patient satisfaction scores associated with their MRI scan," says Dr. Andre. "Overall I think that patients report that they are relatively satisfied with their experience. Our monthly meetings have already been going on for years, so that aspect of the Affordable Care Act has had probably no effect at all on our practice. Luckily we have involved colleagues who foresaw this trend many years ago."

Besides feeding back satisfaction scores to institutions and payers, patients' perspectives are easily disseminated to their peers via social media. The views of satisfied patients can lead to increases in referrals, while negative experiences may result in loss of patients and revenue. «

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Approaches for including MRI in **radiation therapy** planning

UMC Utrecht offers insight in their experiences with integrating MRI into radiation therapy planning workflows

Radiation therapy (RT) uses imaging to support delineating anatomy for dose planning. In general, the aim is to target the tumor and spare the surrounding tissues as much as possible. This requires careful planning to ensure spatial accuracy and calibrated dosing. University Medical Center Utrecht (Utrecht, Netherlands) has embraced MRI to enhance radiation therapy planning with the benefit of its high soft tissue contrast.

Marielle Philippens, MD, PhD, has been a radiobiologist and medical physicist with focus on MRI physics in the department of Radiation Oncology at University Medical Center Utrecht since 2008. Her research interest is functional imaging for oncology, with particular focus on diffusion weighted MR imaging. Her research focus areas are head and neck cancer, rectal cancer and breast cancer.

Good delineation can help spare critical anatomical structures

Advances in radiation therapy delivery devices allow more complex dose plans to be made. This drives the need for better delineation of tumors and surrounding tissues, but defining the target volume is still a challenge. Target delineation allows the radiation dose to be tailored to the anatomy [1-4] so that a high dose can be directed to the tumor, and a lower dose to the surrounding tissue. Ultimately, less radiation on surrounding tissue may help to preserve functionality of healthy tissue.

While CT is used as the standard imaging modality, it suffers from limitations in providing good soft tissue contrast, especially in regions where soft tissue structures are in close proximity to each other [1]. In this context, the benefits of MRI for radiation therapy treatment planning are long recognized. MRI offers high soft tissue contrast, thereby providing anatomical as well as functional information for organ delineation and visualization of surrounding anatomy and critical structures, thereby helping to support good determination of target volume [1].

"Using MRI in radiation therapy means we can differentiate soft tissues and visualize organs and anatomical structures, but it takes some experience to interpret the details seen in the image"

Simplified overview of MR imaging in radiation therapy workflow

Imaging plays a vital role at several steps in the radiation therapy workflow to visualize targets and critical structures for contouring, and to assess treatment response.

Simulation	Registration	Contouring	Dose planning	Treatment	Follow-up
MR /CT imaging in the treatment position	Registration of MR and CT datasets	Contouring target and organs at risk	Dose calculation aiming high dose on target, while sparing critical structures	Radiation therapy delivery in multiple fractions	Follow-up and response assessment

Marielle Philippens, MD, PhD, a medical physicist in the radiotherapy department at UMC Utrecht, further explains: "In treatment of the head and neck, for instance, we always try to save the parotid glands and the salivary glands. In cases of prostate and cervix cancer, we aim to spare the bladder and rectum as much as possible. To achieve this, we need to first find the outline of the target. In my experience, it can be quite difficult to delineate this with CT, even when using contrast agent. This is why the high soft tissue contrast of MRI is attractive for radiation therapy planning."

Choosing MRI protocols for treatment planning

In clinical practice, MRI is mostly used in conjunction with CT for visualization of targets and critical structures [5], while CT is used to delineate anatomical structures and provide Hounsfield Units (HU) for dose calculation.

"MRI can provide different types of contrast," says Dr. Philippens. "This allows us to see more details than on CT. We can differentiate soft tissues and visualize organs and anatomical structures, but it takes some experience, particularly with head and neck tumors, to understand how to interpret the details seen in the image."

"MRI can provide anatomical and functional information. The most important sequence for tumor delineation is the T1-weighted scan after contrast administration. On post-contrast T1-weighted MR images with fat suppression, the tumor can be distinguished due to its high perfusion and leaky vessels. We also use pre-contrast T1-weighted images, which show tumor extension into the fatty tissue.

"On the T2-weighted MRI with fat suppression the tumor with its edematous surrounding tissue can be clearly distinguished. This is particularly useful if the tumor does not show enhancement after contrast injection.

"I like to include diffusion weighted imaging, as it is so easy to see the tumor in these images. In my opinion, it has great potential for tumor delineation and response assessment"

"Diffusion weighted imaging (DWI) shows very high contrast between the tumor and surrounding tissue. DWI helps us to see how a tumor extends into another structure, which we may not see on the T1-weighted or T2-weighted images. However, as DWI images are prone to distortions, these are mainly used to visualize the tumor and for response assessment, and not yet so much for delineation. I like to include diffusion weighted imaging, as it is so easy to see the tumor in these images. In my opinion, it has great potential, both for supporting tumor delineation and in response assessment."

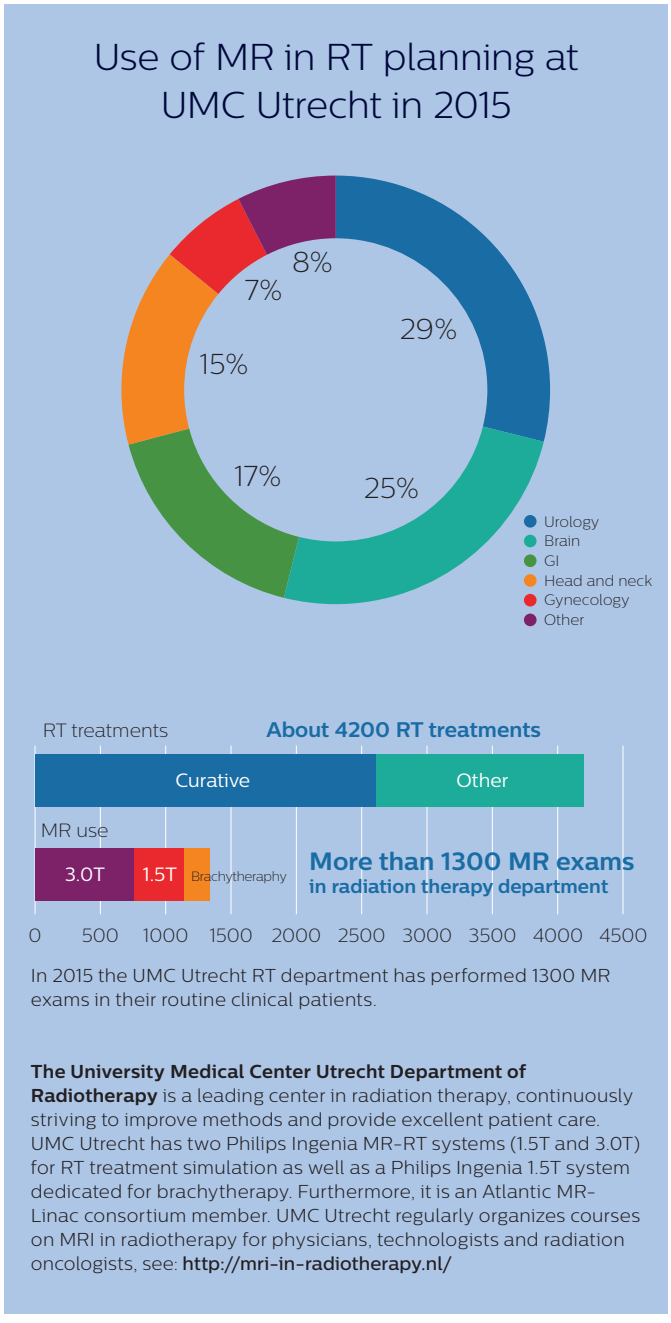
Successful planning requires a good fit between MRI and CT

Ideally, the patient position during the MRI scan should be exactly the same as during radiation therapy treatment, to ensure that organs are in the same position and that the target volume planned on the images will match the volume that is irradiated. Therefore, a flat tabletop and an external laser for patient alignment are often used during MRI to obtain spatial correlation in radiation therapy treatment planning and good coregistration of MRI and CT images. »

"For coregistration of MRI and CT images, we aim to use an MRI contrast type with few non-linearities and good tissue differentiation, preferably acquired as non-angulated axial slices," says Dr. Philippens. "Either 3D scan protocols or multislice 2D protocols with contiguous slices are used to allow target volume reconstruction in the different orthogonal directions."

MRI is used for planning in a variety of anatomies

At UMC Utrecht, Dr. Philippens and her colleagues are using MRI in planning external beam radiation therapy (EBRT) for treatment of tumors in a variety of anatomies, such as organs in the pelvis (including bladder, prostate, rectum and cervix), the brain, the esophagus, pancreas, the larynx and oropharynx, bone metastases and sarcomas. In addition, MRI is also used to guide brachytherapy in the prostate and cervix. [6]



In 2015 the UMC Utrecht RT department has performed 1300 MR exams in their routine clinical patients.

The University Medical Center Utrecht Department of Radiotherapy is a leading center in radiation therapy, continuously striving to improve methods and provide excellent patient care. UMC Utrecht has two Philips Ingenia MR-RT systems (1.5T and 3.0T) for RT treatment simulation as well as a Philips Ingenia 1.5T system dedicated for brachytherapy. Furthermore, it is an Atlantic MR-Linac consortium member. UMC Utrecht regularly organizes courses on MRI in radiotherapy for physicians, technologists and radiation oncologists, see: **http://mri-in-radiotherapy.nl/**

High dose on the lesion rather than on the whole prostate

MRI is capable of visualizing the prostate and the surrounding organs such as rectum, penile bulb, bladder, the apex and seminal vesicles, as well as visualizing intra-prostatic lesions [2,4].

"All our patients undergo an MRI exam – along with CT – before radiotherapy of the prostate," says Dr. Philippens. "For prostate delineation, we are scanning a balanced TFE with fat suppression. We can also see the gold fiducial markers in these images, which are used for position verification and are therefore used for registration to CT. For geometric accuracy of the image, we choose a 3D sequence, which is corrected for the gradient non-linearities in all directions.

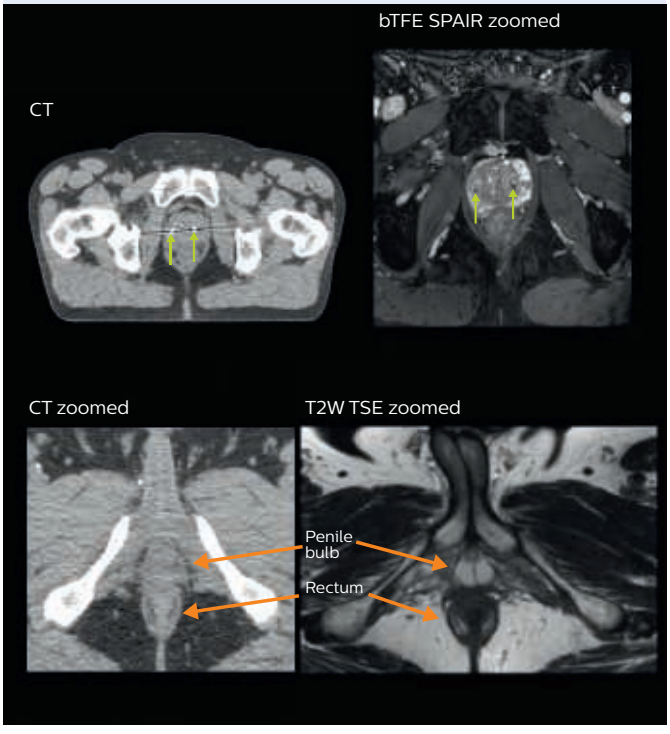
"MRI also helps in visualizing the lesions inside the prostate, which may not be possible in CT"

Visualizing critical structures with MRI before prostate radiation therapy

A 63-year-old patient with prostate cancer, cT3bNxM, Gleason 7, underwent MRI on Ingenia 3.0T MR-RT before radiation therapy.

Intraprostatic lesions are visible on the bTFE MR image, but not on the CT image. MRI shows excellent soft-tissue contrast for the visualization of critical structures like the rectum and penile bulb.

Fiducial markers (green arrows) are used in registration of MR images to CT, to transfer the MR-based delineations onto the CT image dataset.



"In addition to helping in delineation of the prostate, MRI also helps in visualizing the lesions inside the prostate, which may not be possible in CT.

"When we can visualize intraprostatic lesions, the radiation therapist can then plan to boost them, giving a higher dose to those lesions instead of giving a uniform dose to the whole prostate, in the hope to better treat the patient and have less risk of recurrent tumors. However, this is not yet clinical routine. For visualizing the lesions, we not only use anatomical, T2-weighted imaging, but also diffusion weighted MRI and dynamic contrast-enhanced MRI."

Visualizing critical structures in the head and neck

"In patients with a primary tumor in the head and neck area, we do use MRI in daily clinical radiation therapy practice to visualize the tumor and critical structures. This may be used to help sparing of critical structures, such as the parotid glands, submandibular glands, esophagus, optic nerves, brain stem and spinal cord [7]. And postoperatively we scan patients that have tumor growth along the cranial nerves for target delineation," says Dr. Philippens.

"Because of the challenges posed by CT MRI coregistration in this area with many degrees of freedom for motion, we image these patients in a radiotherapy mask. However, one disadvantage of using the mask is that a regular head and neck coil cannot be used; a dedicated coil solution would be needed for imaging with a mask. For this we make use of flexible coils that we position close to the target area. This setup can also be combined with the anterior coil for a larger coverage and enhanced SNR."

"We use pre- and post-contrast T1- and T2-weighted sequences with the fast and robust mDIXON method for fat suppression," says Dr. Philippens. "Dynamic contrast-enhanced imaging is performed with high temporal resolution and low spatial resolution, to see the contrast agent uptake in the tumor. Diffusion weighted imaging is used qualitatively to see how the tumor extends into another structure, rather than for strict delineation."

"In postoperative patients who have had tumor growth along the cranial nerves, we use T2-weighted gradient echo (FFE) on our 3.0T MR-RT scanner to show the nerves for target delineation and look to see if there is still tumor left." »

Comprehensive MRI exam of prostate for RT planning

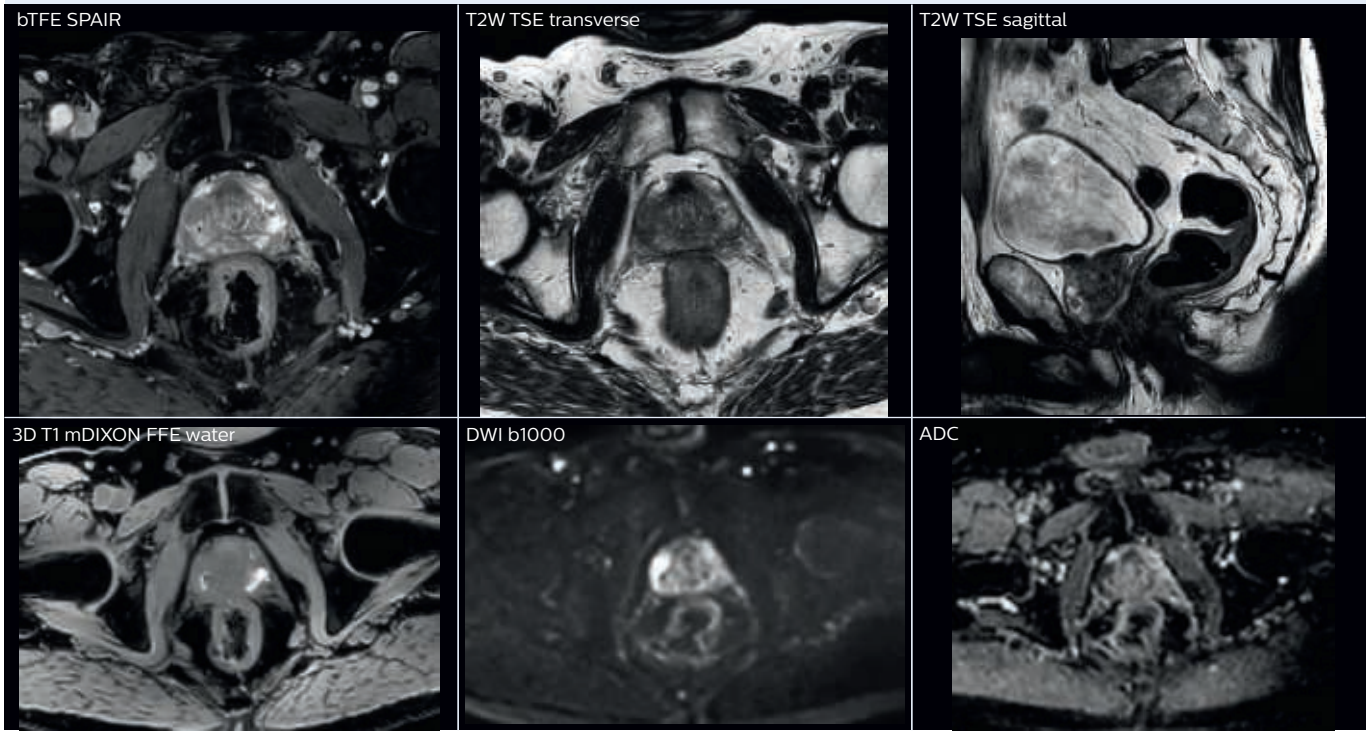
A 70-year-old male with cT3bNxM0, Gleason 6, PSA 7.9 µg/L, was referred for radiation therapy treatment.

The bTFE sequence with SPAIR fat suppression shows the outline of the prostate as well as the gold fiducials. It is important that both are defined in the same, high resolution image, since the positioning of the patient during radiotherapy treatment is based on the position of the gold fiducials.

The transverse and sagittal T2W TSE images help us identify the prostate tumor foci, which typically have lower signal intensity than normal prostate. For patients that are referred for brachytherapy the T2W image is used to identify the presence of extracapsular extensions as these are a contraindication for brachytherapy. The 3D T1 mDIXON FFE is used to identify abnormalities that could be hemorrhages due to biopsies or insertion of fiducial markers. These hemorrhages may look similar to tumor foci on T2-weighted images and ADC map.Transverse DWI with SPAIR and 6 b-values is used to visualize the tumor foci (bright appearance), which mostly have a low ADC.

Dynamic T1 FFE with 120 dynamics and 2.4 sec. temporal resolution is also used visualize the tumor foci, which often show a high perfusion.

Philips Ingenia 3.0T using the Anterior coil and the integrated Posterior coil.



MRI of head and neck for radiation therapy planning

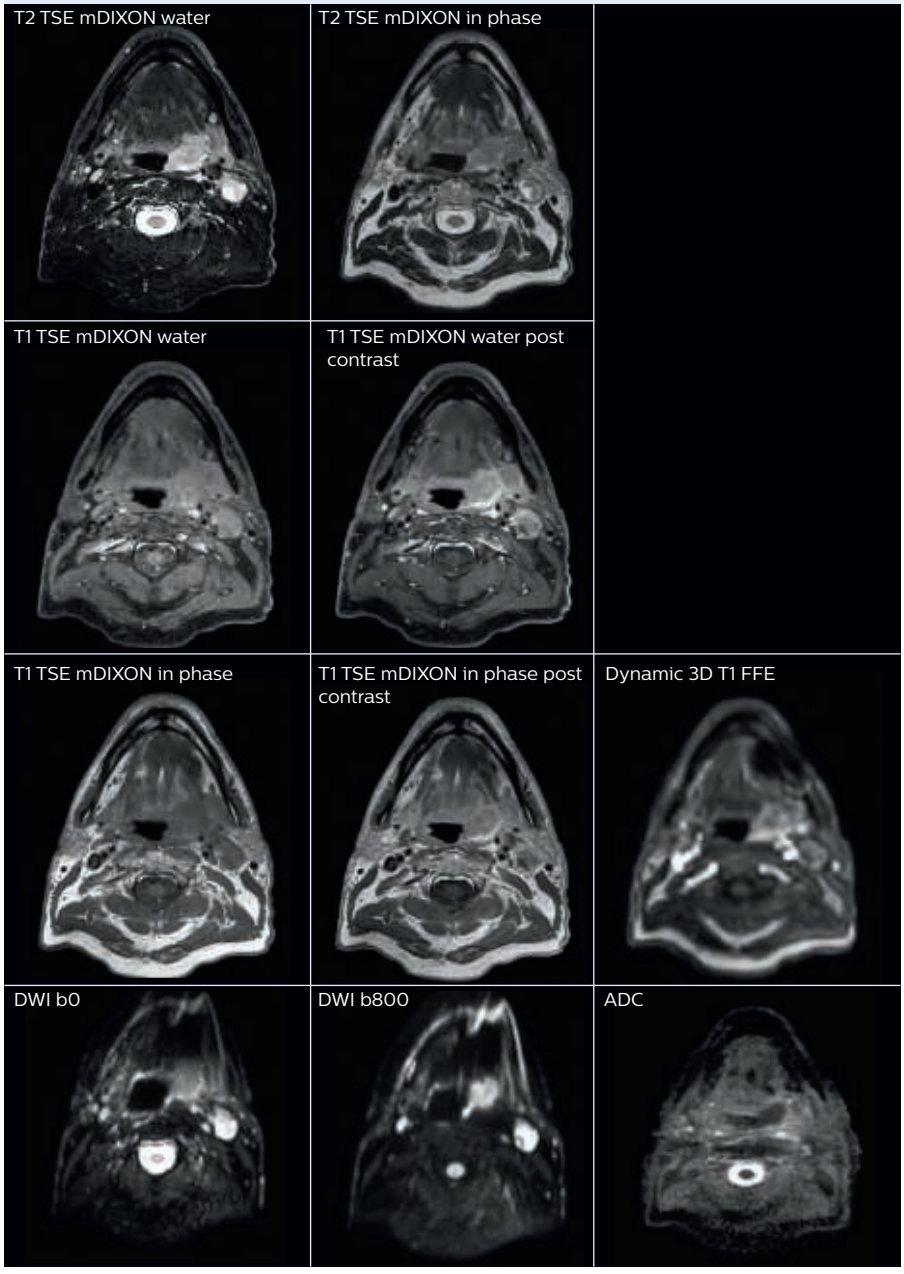
A 75-year-old male was referred for radiation therapy treatment of oropharynx squamous cell carcinoma in the left tonsil region with extension into the soft palate, caudal border lower tonsil region, no midline crossing. On the left side in the neck there are also three enlarged lymph nodes on level 2 and 3 with central necrosis and signs of limited extracapsular extension, T2N2b.

The patient undergoes MRI in the radiotherapy (5-point) positioning mask in Ingenia 3.0T using the Flex coils. DWI with SPIR is used to visualize the extension of the tumor and lymph nodes, especially retropharyngeal. Transverse T1 and T2 TSE mDIXON water and in-phase images (2 mm thick slices) help to visualize the tumor size and its extension into fatty tissue. The post-contrast T1W TSE mDIXON also shows this.

Dynamic 3D T1 FFE with 45 dynamics and temporal resolution of 2.5 seconds is performed to follow contrast agent distribution. Contrast agent distribution is modeled after conversion of the signal to T1 relaxation times using the small flip angle method.

Clinical value

Using different contrasts (T1, T2, diffusion, post-contrast T1) in MRI allows us to appreciate contrast changes in the tumor and in the vicinity of the tumor. This helps to delineate the tumor. MRI and especially DWI also helps to visualize the retropharyngeal lymph nodes.



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Running a **successful MRI service**, what does it take?

Insights from private practices in Germany and India that are planning on expanding their MRI capabilities

In a highly competitive marketplace, running an MRI service as a successful business goes beyond the provision of high quality imaging. Two owners of thriving MRI services in Germany and India share their insights into the key success factors of running and expanding a successful MRI practice.

"Especially in the private sector, uptime is very, very important"

Dr. Parveen Gulati runs the Dr. Gulati Imaging Institute, a privately owned, multi-modality imaging center in New Delhi, India. Dr. Gulati's institute offers MRI, CT, ultrasound, X-ray and mammography. Dr. Gulati is planning to expand the Institute's MRI capabilities, adding new equipment in the near future.

Mrs. Silvia Schiffer runs Radiology Schiffer, a privately owned imaging center attached to a major hospital just outside Berlin, Germany. Radiology Schiffer currently offers MRI, CT, and X-ray services, and Mrs. Schiffer will soon establish a new fully equipped center with two new MRI machines, CT, X-ray and ultrasound systems.

Clinical excellence and operational efficiency drive growth

Expanding MRI services typically requires investment in innovative technological solutions that will enhance clinical excellence while also boosting operational efficiency.

Clinical excellence is augmented by solutions that deliver high performance imaging, allowing for diagnostic confidence across the spectrum of clinical procedures. Operational efficiency is supported by equipment that allows high patient throughput to accommodate an increasing demand for MRI scans. Ideally, reliability and high uptime are combined with a fast and comfortable operator workflow.

Cost considerations are paramount

An entrepreneur who is building or expanding MRI services, needs costs to be predictable and affordable to ensure financial security over the entire lifetime of the equipment. It includes maintenance costs, system upgrades, application support and also staff training.

The patient remains at the center of it all

Ensuring patient comfort during scans, improving patient satisfaction, and reacting to patient feedback are key objectives for any MRI service. Satisfied patients enhance the reputation of an MRI practice, attracting new patients and expanding business opportunities. »

Providing quality for **minimal cost** in India

Dr. Parveen Gulati runs a highly successful multi-modality imaging center in the fashionable Hauz Khas Enclave in New Delhi, India. The Dr. Gulati Imaging Institute provides a wide range of services, including MRI, CT, ultrasound, X-ray and mammography.

"We do between 30 and 35 MRIs per day," says Dr. Gulati. "This is a mixture of all kinds of procedures including brain imaging, joints, breast and prostate. And we have two radiologists looking after the MRI unit."

Providing an MRI service in India has some specific challenges compared with the West, Dr. Gulati explains. "In our country there are a lot of people who are below the poverty line who attend state-run hospitals that don't have MRI facilities. So we need to provide them with imaging services at a concessional rate. The disease scenario is also a little different because in our country infection is very common, especially in the pediatric age group. We see a lot of tuberculosis patients who are probably not so frequently seen in the Western world."

"We are staying ahead by focusing on quality"

Increasing competition drives need to stand out

Growing prosperity and rising costs in India are putting pressure on private MRI providers, says Dr. Gulati. "We were among the first to start an MRI practice in the private sector here. But over the years, with the improving economy and easy availability of funds, a lot of centers have opened. A major challenge right now is the increasing competition. Then there are increasing running costs of the centers, the costs of radiologists, technologists and supportive staff, not to mention the infrastructure costs. Electricity in India is more expensive now. Patients rightly want the best care that's available in the world, but they want it at a minimal cost."

However, in this climate of strong competition, the quality of service provided can be a key differentiator, says Dr. Gulati. "Our center is one of the first centers in the country to receive accreditation by the Quality Council of India. We have also received an award by the Federation of Indian Chambers of Commerce and Industry for organizational competence. We are primarily staying ahead by focusing on quality."

Ease of operation facilitates high throughput

Operating within tight margins requires high patient volumes for profitability, and that calls for fast, efficient scanning. "Fast sequences are essential for us to increase throughput," says Dr. Gulati. "In India we basically rely upon the volumes to make the project viable. For that we need a really high throughput."

"If you consider the cost of the equipment I use, the MRI machine price is the same as in the Western world. But if you just look at the cost of an MRI scan, in our country we only charge around 50 to 70 US dollars. In the West they may be charging

"I want the confidence that somebody will support me if my equipment goes down in the night"

"Fast sequences are essential for us to increase throughput"

something like 1,000 US dollars, maybe more. We can only compensate on volume, so it is very important for us that our equipment should be capable of doing scans that are fast. For that we need proper training, availability of faster sequences, good technical support and good application support. The equipment should be user friendly, both for the operations at the console as well as for managing the patient at the magnet."

High uptime is crucial for financial viability

"Especially in the private sector, uptime is very, very important," says Dr. Gulati. "We do not want our equipment to be down for a single minute. Not even for routine servicing and preventative maintenance. We always prefer that this should happen either on a Sunday or at night when the working day is over. For me, service back-up is very important. What I want is the confidence that somebody is there to support me if my equipment goes down in the night. Those types of support are crucial."

Confidence in image quality and lifetime support

"Next to cost, the main factor is the performance of the MR system. It comes down to confidence: my confidence in the image quality, my confidence in its user friendliness for my technical staff, and my confidence that I will get timely upgrades. But most importantly – which I want to give the maximum emphasis to – is the confidence that I have good application support and a service back-up."

Predictable costs facilitate growth

The Dr. Gulati Imaging Institute has plans to consolidate its position as one of the foremost imaging centers in India with a program of expansion in the near future. "Before we can really think of expansion," says Dr. Gulati, "as with any other business, we want to know the total cost of the project's expected inflows and outflows. Predictable outflows of money are very important, and that includes the service contracts for equipment, and the scope and cost of future upgrades."

Finding well-trained staff can also be problematic for an expanding business. "Even getting good technologists can be difficult. We need expert technologists who can manage the MR machines. In fact, I have suggested to the vendors that they should start their own training program for technologists. If they trained more technologists they would be an asset to established centers and the up-and-coming centers as well."

Upgrades needed to stay at forefront

The ability to remain at the forefront of technological developments without frequent investment in new hardware is a key factor for a private MRI practice in India, explains Dr. Gulati. "Upgradability is a very important factor. In fact, every company should take that into account with their equipment. We cannot change equipment very frequently, but vendors are constantly coming out with newer features for MR, and those advancements should be made available to the customer at a reasonable price and with proper application support so they can exploit the equipment to its maximum."

Satisfied patients are the best measure of success

There are many possible measures of success, but Dr. Gulati explains that in his opinion, one measure far outweighs the others. "Success is a continuous dynamic process," he says. "In any organization there are a number of parameters you can define, but for me the most important parameter is patient satisfaction. Our practice is totally patient oriented. We are basically doctors, so our primary goal is to keep our patients happy. And on the business front, if patients are happy they will bring you back another patient."

"If patients are happy they will bring you back another patient"

»

Communication and **management** are crucial for building a thriving MRI practice

Mrs. Silvia Schiffer runs Radiology Schiffer, a successful, privately owned MRI practice embedded within a large hospital in Hennigsdorf, just outside the German capital of Berlin. She currently has one MR system and offers additional CT and X-ray services.

Radiology Schiffer is run as a small business, and Mrs. Schiffer identifies two important aspects that contribute to success. "Good cooperation and collaboration with the hospital and colleagues are required in order to maximize the utilization of our equipment. We work as a service provider for referring physicians, and the system has to be available and as reliable as possible."

Another challenge concerns recruiting and retaining good staff. "One of the biggest challenges is the recruitment, the ongoing education and training, and the retention of the right staff that help us provide a top level of service."

"The predictability of costs is extremely important"

Expansion requires predictability of costs

In the near future, Mrs. Schiffer plans a major expansion. "I'm currently setting up a completely new practice, at a different location, with two new MRI machines, a CT, an X-ray and an ultrasound system."

Among the many considerations when embarking on a new venture, solid financial forward planning is essential. "The predictability of costs throughout the lifetime of equipment is extremely important to run a practice in a profitable way on an ongoing basis," Mrs. Schiffer says. "Beyond just the MRI machine price, we need to have a clear forecast of future costs that will occur. This includes service costs and the cost of application support, which are very important to maximally use the possibilities that these expensive systems offer – which is again critical for standing out in the market."

A thriving MRI service balances quality and throughput

"For a private practice," says Mrs. Schiffer, "the balance between the quality of imaging and patient throughput is critical. A private practice needs a high number of patients to succeed. To a certain extent, we have to keep the duration of an exam as short as possible with the highest possible quality. This is a difference between a private practice and a hospital, which may not be so focused on this aspect."

“It is not only equipment itself, but the total added value that comes with it”

“The balance between quality of imaging and patient throughput is critical for a private practice”

Maintaining that balance between quality and throughput has many associated factors, but it is facilitated by the ease of daily operation of MRI scanners, Mrs. Schiffer explains. “We keep our staff well trained, but having machines that are intuitive to use, that are quasi-self-explanatory, with a well-structured operating interface, is very important to support our fast and efficient workflow.”

High uptime is essential to success

Sustaining a high patient throughput requires keeping MRI scanners in continuous operation. “Minimizing downtime is essential for us, because we have a fully booked schedule of patient exams and waiting times.

We feel it would offend referring physicians and patients when we have downtime and then need to reschedule patient exams,” says Mrs. Schiffer. “Keeping patients to schedule demands a high uptime. Maintenance should be limited to those hours where the practice is not open, in order to ensure the optimization of uptime. It is important also for the reputation of the practice, and for maintaining referrals. High uptime gains trust and confidence in the practice.”

Upgradability helps maintain a competitive position

Staying ahead of the competition means staying ahead in terms of technological advances, explains Mrs. Schiffer. “The ability to upgrade equipment from time to time is essential to provide a state-of-the-art level of service. There are practices here in Germany that are still using 20-year-old, 0.5 tesla equipment to generate images and results. And as long as the patients are not harmed, this is fine. But that’s not the point. If the images are not of the highest quality, then the results derived from those images, which are handed back to referring physicians, are also not of the highest quality. Providing the highest possible image quality, and therefore optimal results and diagnoses, is how we want to earn our position in the market.”

Total package, not just MRI machine price, determines best offer

How does a private MRI practice make purchase decisions? “It is always the total package that determines what the best offer is,” says Mrs. Schiffer. “It is not only equipment itself, although that is obviously very important, but also the added value that comes with it – the future collaboration, service, and support on technical as well as operational matters, and hopefully, also support for the marketing aspects. Branding of the practice is an important consideration, but also cooperation with the right vendor. Both are important if I am to gain a premium position for my practice compared with the competition around me.”

To conclude, Mrs. Schiffer summarizes what she considers crucial for building a thriving practice. “I believe that the success of a radiology practice is ultimately based on the combination of being a knowledgeable radiologist and at the same time being an entrepreneur. Staff management is very important and so is finding your niche in the market. It requires branding and evidently a lot of communication, with the manufacturer, but also particularly with referrers and colleagues. After having been preparing this for a year, I can clearly say that marketing, networking and good management of a practice are certainly different from just taking a physician’s viewpoint.” «

“Keeping patients to schedule demands a high uptime”

Imaging small **cerebral** aneurysms using non-invasive **MR angiography**

3.0T MRA without contrast agent demonstrates high performance in cerebral aneurysm imaging

The Sixth Affiliated People's Hospital, Shanghai Jiao Tong University (China), uses time-of-flight MR angiography (TOF MRA) to visualize cerebral aneurysms. The team has high confidence in their 3D TOF MRA method when imaging patients with small aneurysms.

“3D TOF is easy to use and the background signal suppression is very good. We use SENSE to shorten the scan duration”

Yuehua Li, MD, PhD, Professor of Radiology at The Sixth Affiliated People’s Hospital, Shanghai Jiao Tong University, China.

Visualizing small aneurysms

“Visualization of small cerebral aneurysms is relevant because detection of unruptured aneurysms can influence patient care,” notes Yuehua Li, MD, PhD, professor of the radiology department. “After follow-up examinations, patients with high-risk aneurysms can receive therapeutic interventions to decrease the risk of rupture.”

“Our team highly appreciates the capabilities of MRI for non-invasive visualization of aneurysms smaller than 5 mm. Both MR and CT can be used to image aneurysms, but MR angiography can be performed without contrast agent, and without ionizing radiation it is not influenced by skull bones.”

High resolution and high SNR are essential

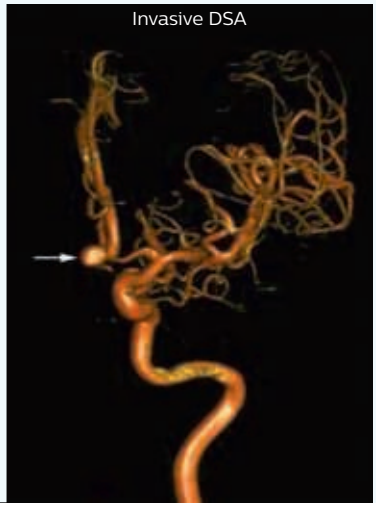
Dr. Li uses a protocol based on 3D time-of-flight (TOF) MRA. “High resolution and high SNR are the most important factors when visualizing small aneurysms. In order to achieve that, scan duration is the trade-off,” Dr. Li says. “To shorten the scan duration we use SENSE.”

“The 3D TOF MR angiograms are obtained by using 3D T1-weighted FFE sequences (TR 35 ms, TE 7 ms, flip angle 20 degrees, field of view 250 × 190 × 108 mm, matrix 732 × 1024, four slabs, 180 slices of 0.8 mm thickness, acquisition time 8:56 minutes). On our Achieva 3.0T MRI system with an 8-channel head coil, 3D TOF is easy to use and the background signal »

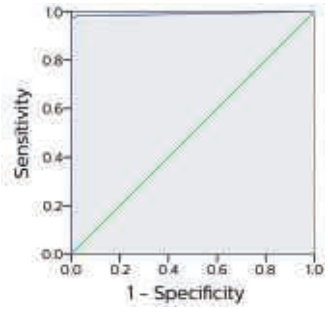
Small aneurysm on 3D TOF MRA and DSA

3D TOF MR angiography non-invasively demonstrates this small cerebral aneurysm that also appears on DSA, which is an invasive procedure.

Achieva 3.0T with an 8-channel head coil, 3D T1W FFE, TR 35 ms, TE 7 ms, flip angle 20 degrees, FOV 250 × 190 × 108 mm, matrix 732 × 1024, 4 slabs, 180 slices of 0.8 mm, scan time 8:56 min. MIP and volume-rendered images are reconstructed. Single-artery highlighting method used to reduce arterial overlay.



Receiver operating characteristics (ROC) curve for aneurysm based evaluation



"We recommend that 3D TOF MRA would be an additional approach for patients with small cerebral aneurysms, due to its non-invasive nature and high degree of accuracy and sensitivity" [2]

MR angiography of multiple cerebral aneurysms

3D TOF MRA demonstrates bilateral aneurysms arising from C5 and C6 segments.

Achieva 3.0T with an 8-channel head coil, 3D T1W FFE, TR 35 ms, TE 7 ms, flip angle 20 degrees, FOV 250 × 190 × 108 mm, matrix 732 × 1024, 4 slabs, 180 slices of 0.8 mm, scan time 8:56 min. MIP and volume-rendered images are reconstructed. Single-artery highlighting method used to reduce arterial overlay.

5 years MRA follow-up of unruptured aneurysm

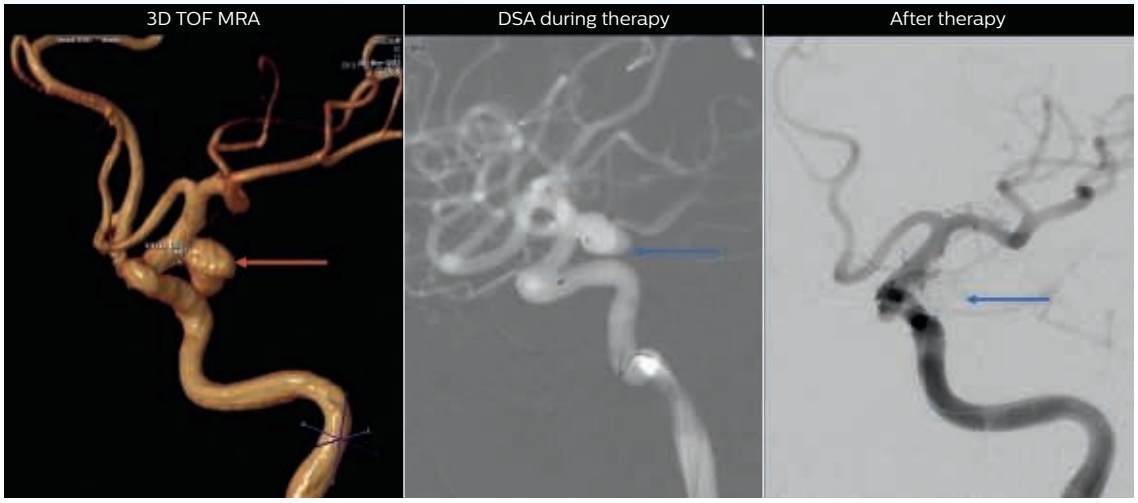
A cerebral aneurysm on the C5 segment in a 57-year-old female was followed over a period of 5 years using 3D TOF MRA. The 5 years follow-up using 3D TOF MRA shows that the aneurysms didn't change much, which indicates that the aneurysm is stable and intervention therapy was not needed.

Achieva 3.0T with an 8-channel head coil, 3D T1W FFE, TR 35 ms, TE 7 ms, flip angle 20 degrees, FOV 250 × 190 × 108 mm, matrix 732 × 1024, 4 slabs, 180 slices of 0.8 mm, scan time 8:56 min. MIP and volume-rendered images are reconstructed. Single-artery highlighting method used to reduce arterial overlay.

MRA of high risk cerebral aneurysm

Volume rendered 3D TOF MRA image visualizes an irregularly shaped cerebral aneurysm arising from the C7 segment. The physician qualified the lesion as instable and interventional therapy was performed. 3D DSA after therapy indicates that the aneurysm has been occluded completely.

Achieva 3.0T with an 8-channel head coil, 3D T1W FFE, TR 35 ms, TE 7 ms, flip angle 20 degrees, FOV 250 × 190 × 108 mm, matrix 732 × 1024, 4 slabs, 180 slices of 0.8 mm, scan time 8:56 min. MIP and volume-rendered images are reconstructed. Single-artery highlighting method used to reduce arterial overlay.



suppression is very good. Maximum intensity projections (MIPs) and volume-rendered images are reconstructed from the data. We use a single-artery highlighting method to reduce arterial overlay. The method can also be used for carotids or other small intracranial vessels."

Study shows high accuracy

"Advances in MR imaging, the high SNR and spatial resolution of 3.0T, increasing observer experience and improved postprocessing techniques have improved the capabilities of MRA over the last decade. We found that 3D TOF MRA provides excellent images for the visualization of small cerebral aneurysms which enables us to accurately diagnose, and this accuracy appears to be similar to that obtained with DSA according to data from a 2014 study," [2] Dr. Li says.

"Aneurysm location can influence how easy it is recognized. Infundibula can mimic aneurysms, adding to the difficulty of interpretation. On MIP images, small aneurysms can also be easily misinterpreted when the aneurysm overlaps with the vessel. This is why in our method we are viewing the images from multiple angles."

"In the hundreds of patients with aneurysms that we scanned, we saw no significant differences in accuracy, sensitivity or specificity among the locations. [2] We think this is the result of technical advances in image acquisition and postprocessing algorithms."

3D TOF MRA chosen for prevalence study

"Our high confidence in the 3D TOF MRA method was the reason to select this method for a study on the prevalence of unruptured cerebral aneurysms in Chinese adults, which involved finding the location and size of unruptured cerebral aneurysms. By the way, that study found a prevalence of 7% and most lesions had a diameter of less than 5 mm," [3] says Dr. Li.

According to Dr. Li, the good performance of MRA makes it a candidate to replace DSA. "We recommend that 3D TOF MR angiography would be an additional approach for patients with small cerebral aneurysms. This is due to its non-invasive nature, ease of use and high degree of accuracy and sensitivity," he concludes. «

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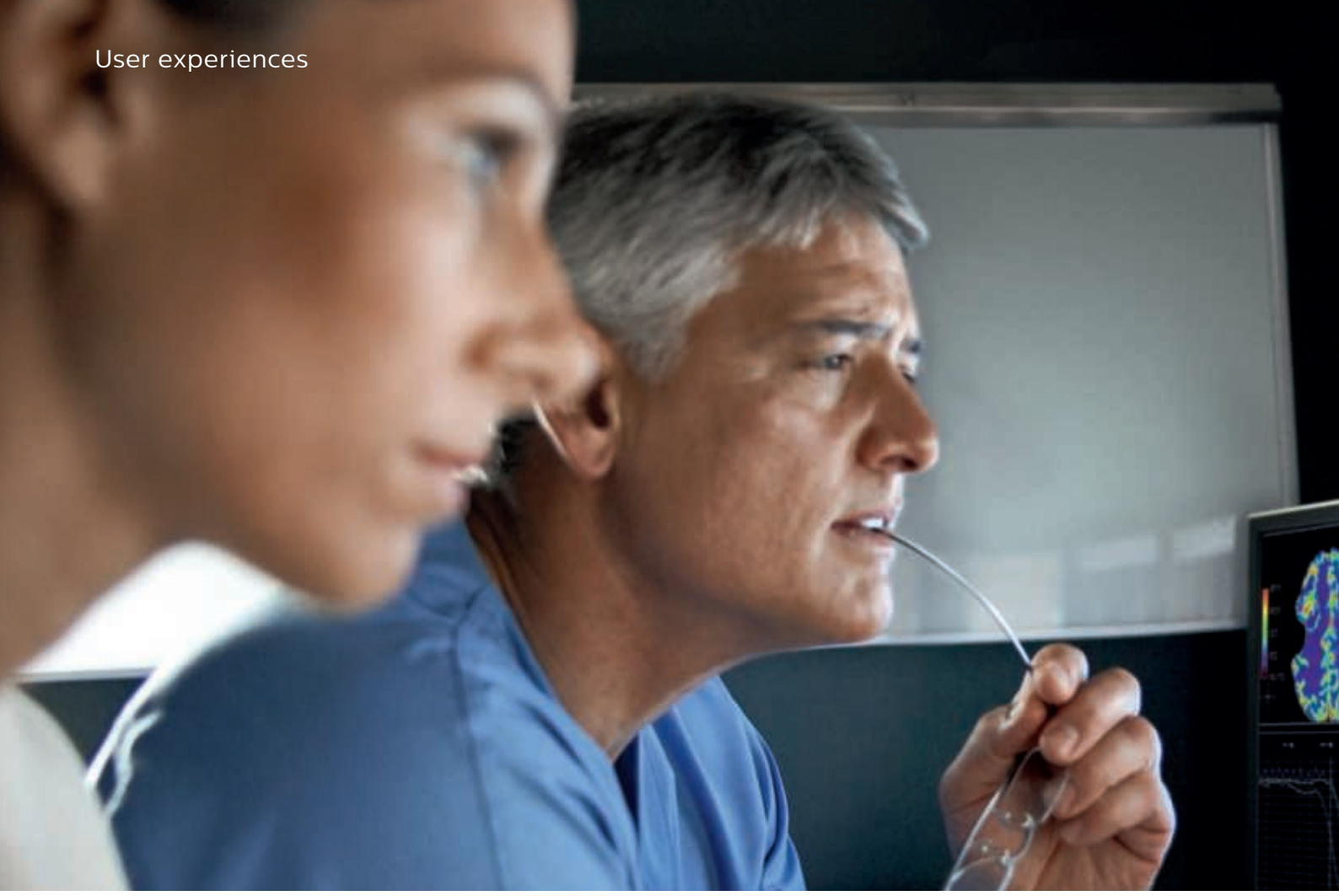


Smart Display Protocols help radiologists speed up their viewing of MRI cases

In a routine radiology practice, IntelliSpace Portal 8.0 saves radiologists precious time in the daily workflow

By automating many steps, Smart Display Protocols (SDP) eliminate many of the manual steps that previously added to the time needed for reviewing and processing MRI images on IntelliSpace Portal. This significantly improves the workflow for radiologists at Beau Soleil Clinic.

Dr. Muriel Viala-Trentini

"A technological advance that actually delivers; it improves workflow for every patient"

SDP replaces manual steps for faster workflow

The radiology department of Beau Soleil Clinic (Montpellier, France), led by Dr. Muriel Viala-Trentini, recognizes IntelliSpace Portal 8.0 as an efficient tool for MR image review and analysis. IntelliSpace Portal 8.0 introduces automatic launch of the initial viewing setup environment matching the radiologist's preferences for the case type. The setup choice is based on preferred display protocols that the radiologist previously saved. These so-called Smart Display Protocols (SDP) thus automatically provide an identical viewing setup for every patient with a similar MRI exam.

One reviewing and visualization tool for all imaging modalities

The clinic performs on average 50 CT scans and 35 MRI examinations each day. "We view and analyze all of the data collected on IntelliSpace Portal to make the diagnosis. Every patient scanned at the clinic leaves with the report of the scan, so reviewing by the radiologist needs to be as time efficient as possible," says Dr. Viala-Trentini.

Dr. Viala-Trentini specializes in women's radiology. "I typically plan my daily scan schedule by clinical area in order to group exams of the same organ together, which facilitates access to the display protocols stored in the database. This is particularly important when protocols need to be found manually, as we can lose time searching if we need to switch between organs every time. Generally, I allocate 10 minutes to review an exam. I typically spend about 80% of my reading time in the multi-modality viewing application and about 20% in the diffusion imaging application."

A technological advancement that actually delivers

The Beau Soleil team had been discussing with Philips for a while about addressing one drawback they had experienced using IntelliSpace Portal 5.0. "Each time we opened a new case for review, we needed to manually organize the display," explained Dr. Viala-Trentini. "This increases the time required for reviewing the case and the number of clicks performed. This repetitive task bothered us and we felt that a more efficient approach could benefit our workflow and save us time."

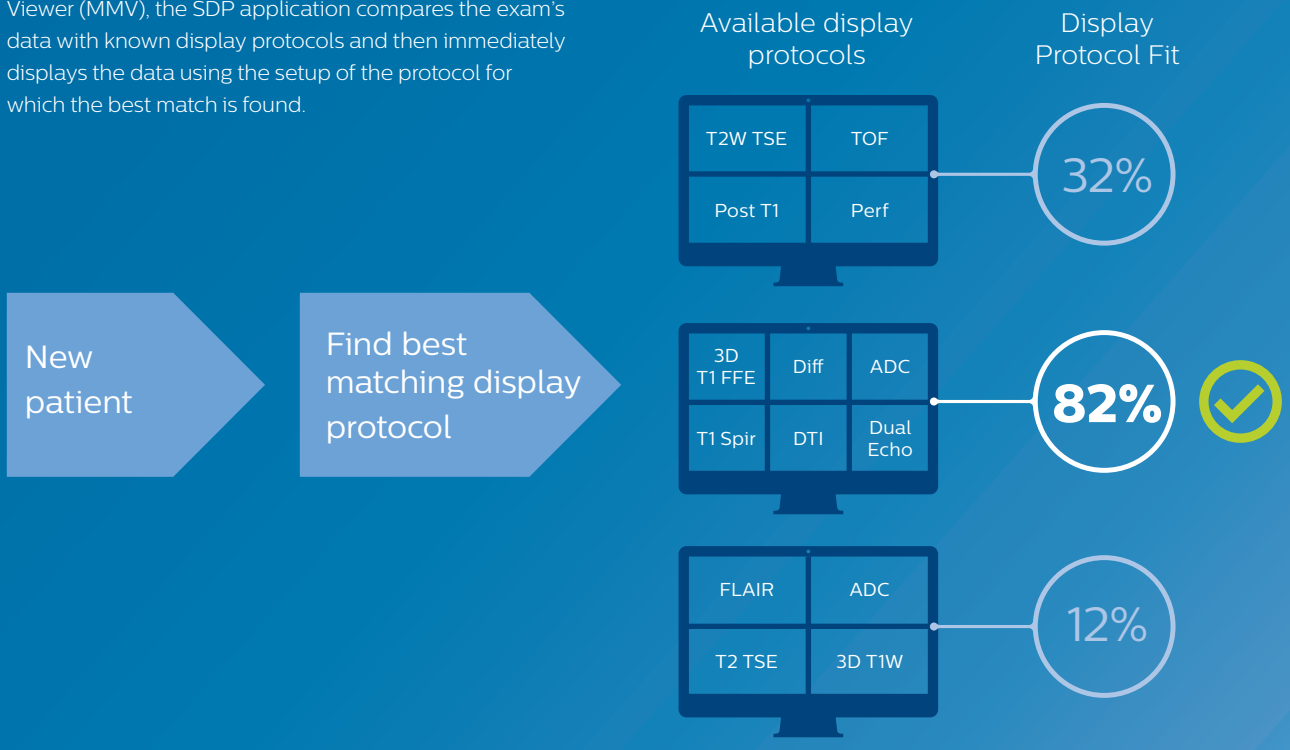
"Philips couldn't have been more helpful", says Dr. Viala-Trentini. "We feel that Philips had really listened to what we were saying and adapted their system to our needs". When Philips placed the IntelliSpace Portal 8.0 system in her department, she and her colleagues tested the modified software under everyday conditions. »

Beau Soleil Clinic (Montpellier, France) is a private clinic, in this region of France renowned for its wealth of surgical and medical expertise. With its team of eight radiologists, Beau Soleil Clinic serves as a reference center for specialist cases in four areas of expertise: women's radiology, urology, digestive tract and orthopedics. With one CT scanner and one MRI machine the clinic boasts capacity for ultrasound and mammography, and also provides 24/7 coverage for accidents and emergency services usage of its MRI. Approximately 500,000 patients pass through the clinic each year with 9000 CT scans and 7000 MRI exams performed annually.

How **Smart Display Protocols** works

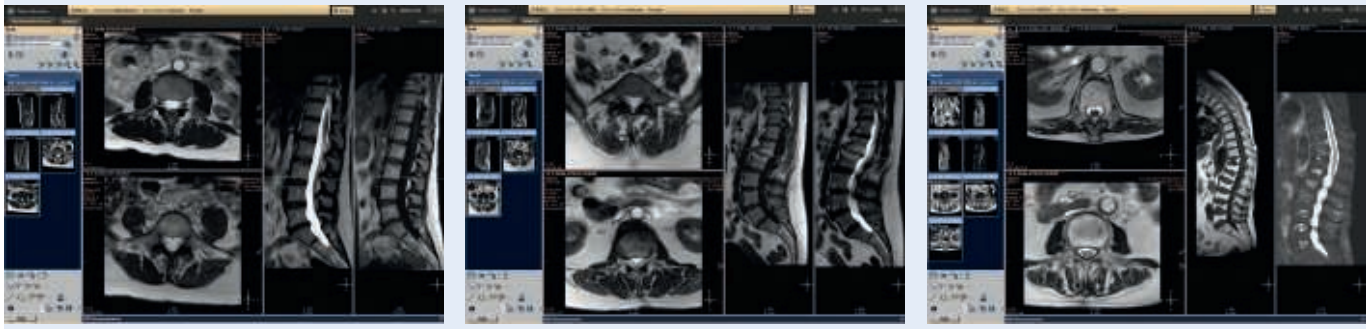
Using IntelliSpace Portal 8.0 with Smart Display Protocols (SDP) allows a user to save the user's preferred display protocols. Once saved, IntelliSpace Portal 8.0 remembers what type of data (anatomy, type of sequence, orientation etc.) is associated with these protocols.

When a new patient is loaded into the Multi-Modality Viewer (MMV), the SDP application compares the exam's data with known display protocols and then immediately displays the data using the setup of the protocol for which the best match is found.

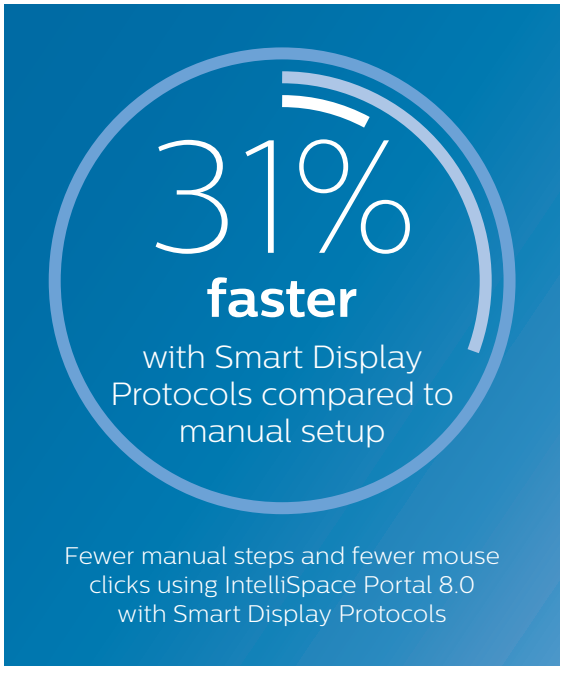


Find out more on **www.philips.com/intellispace**

Different cases, same screen setup ... automatically!



These examples show how the spine MRI exams from the different patients are all presented to the reading radiologist in a similar setup. Even when the original study is not fully identical, the Smart Display Protocols automatically presents the results in an identical manner.



With Smart Display Protocols, IntelliSpace Portal 8.0 automatically identifies the best fitting display protocol (screen layout for viewing) for each new patient and applies that. The choice is based on previously used displays that have been actively saved by the user as preferred displays. These are also accessible to other users if they are faced with similar pathology.

"One of the most positive things about this technological advancement is the fact that we can have faith in it. The display protocol I need automatically appears the minute I begin to work," says Dr. Viala-Trentini. "This successful solution is an advancement that actually improves my workflow for every patient."

SDP speeds up reviewing and workflow efficiency

The radiology department of Beau Soleil Clinic has compared the efficiency of IntelliSpace Portal 8.0 software with their previous version IntelliSpace Portal 5.0, in terms of time to protocol display and number of clicks used. In a study carried out in 25 patients over a two month period, the team found that SDP significantly improves workflows.

"We compared the IntelliSpace Portal 5.0 and 8.0 directly in four different pathologies: breast, pelvis, prostate and musculoskeletal. We found – with the same radiologist reviewing all pathologies – that there was time saved when doing the review with IntelliSpace Portal 8.0," says Dr. Viala-Trentini.

"The time saving comes primarily from the automatic uploading of the relevant display protocols, so that all necessary images are immediately ready for review. Thus, fewer manual steps and mouse clicks are required. Although this might sound minimal, we showed that this improved workflow makes display set-up time 31% faster compared to manual setup. This has led to a marked improvement in workflow as more efficient reviewing means that a busy department can run more efficiently and fluidly. The reduction of mouse clicks allows me to focus immediately on the patient instead of on managing the system."

The conclusion from Dr. Viala-Trentini is clear: "Smart Display Protocols is a great improvement for our day-to-day work: the software has improved workflow that matters for every patient-review." «

Philips is the **world's largest patent applicant** at the European Patent Office

Also ranking first in three leading technology fields: 'Medical Technology', 'Electrical machinery, apparatus, energy' and 'Measurement'

In March 2016, Royal Philips announced that it is the world's largest patent applicant for patents filed at the European Patent Office (EPO) in 2015. Last year Philips filed 2,402 patent applications according to the 2015 Patent Applicant Ranking, which was released by the EPO.

Philips rose to first place in 2015 from the second position in 2014 in the EPO's annual ranking. In addition, Philips ranks first in three of the ten leading fields of technology: 'Medical Technology', 'Electrical machinery, apparatus, energy' and 'Measurement.'

Philips was by far the largest patent filer from the Netherlands – responsible for one third of all patent applications by Dutch companies – and therefore strongly contributing to the rise of the Netherlands as second largest country in the world in terms of patent applications at the EPO per million inhabitants.

March 2016. Patent figures with courtesy of the European Patent Office.
For more information about Philips Intellectual Property and Standards: www.ip.philips.com

Philips' current IP Portfolio consists of 76,000 patents, 47,000 trademarks, 91,000 design rights and 5,000 domain names.

"We are very proud of becoming the world's largest patent applicant at the EPO in 2015," said Brian Hinman, Chief Intellectual Property Officer at Philips. "It underscores the innovative power of Philips. Impressive numbers, yet for us, the quality and value of our IP portfolio remains more important than quantity."

Philips leverages advanced technology and deep clinical and consumer insights, delivering integrated solutions and innovations to improve people's lives and enable better outcomes across the health continuum, from healthy living and prevention, to diagnosis, treatment and home care.

"With our strong IP portfolio we protect these solutions and innovations which support the company's growth, competitiveness, profitability and create new business opportunities," Hinman adds.

"Philips has consistently been among the most active applicants at the EPO for many years and for the company to have been the EPO's top applicant in 2015 is a great achievement. The prominence of Philips and other European companies in our top ten attests to the dynamism of European inventors and innovators," said Benoît Battistelli, President of the European Patent Office.

The full press release and supporting materials made by the European Patent Office can be found on **www.epo.org**. More information about Philips Intellectual Property & Standards can be found on **www.ip.philips.com**. «

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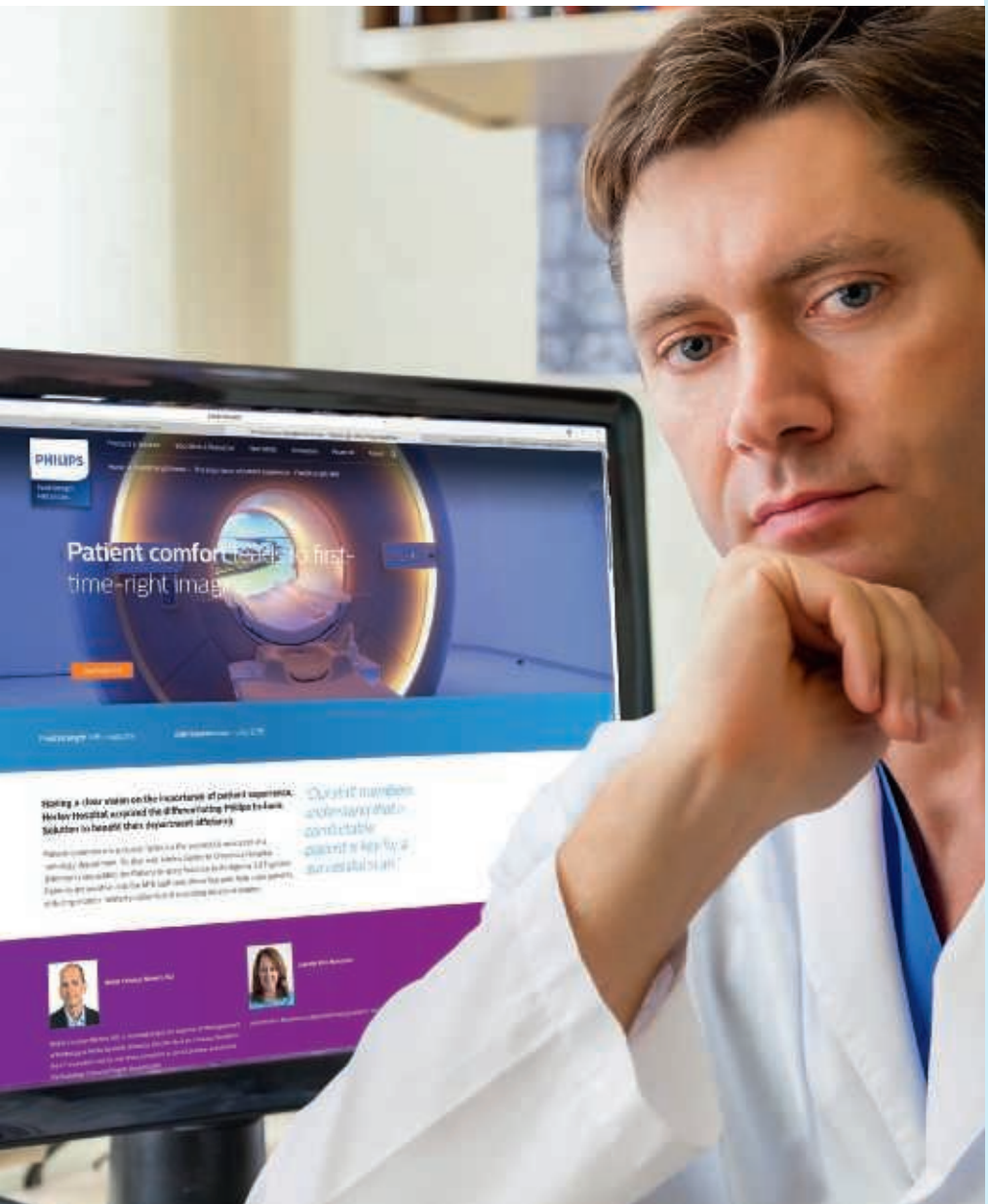

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