visions

MAGAZINE FOR HEALTH PROFESSIONALS
European Edition // No 38 // March 2022

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Canon

Canon Medical introduced SilverBeam, a beam shaping energy filter that delivers AI enhanced, high quality, low noise CT images optimized for lung screening. Read the article in this VISIONS issue on pages 12-14.

VISIONS magazine is a publication of Canon Medical Europe and is offered free of charge to health professionals.

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News, articles and the full edition of VISIONS magazine are announced firstly, as pre-publication, via the dedicated VISIONS LinkedIn Group: https://www.linkedin.com/groups/3698045. In this group you can actively participate in discussions about the content and future direction of the magazine.

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 ISSN 1617-2876

// EDITORIAL

Dear Readers,

Every time I receive and read through a new edition of VISIONS magazine, I realize just how strong the bond with our customers really is. It becomes clear every time that this is because they value our products, services, as well as a long-lasting relationship developed with Canon Medical, which has usually evolved, over many, many years, and even decades in some cases.

Listening to the voices of our customers, I see how we continue to deliver our professionalism to the world through our broad knowledge, experience and commitment, and I am extremely proud of and grateful to our teams for this.

Looking back over the past two years, the world surrounding us has changed significantly. Our everyday lives have been severely impacted by the Covid-19 pandemic, and our way of working has changed. In our business environment, the market has evolved significantly in response to the challenges that our customers have faced. Reflecting on this, we remain committed to adjusting our own business to ensure that we continue to address the needs of healthcare professionals.

Overall, it has become even more obvious how important and valuable 'Made for Life' is to us and our customers - guiding our responses to the challenges of the times and enhancing our drive to meet customers' needs and assist in improving care for patients.

In 2021, we were still able to continue growing our European business, despite all the difficulties the pandemic and other challenges that the year presented. In 2022, we will continue on our path to realize our Made for Life philosophy in wider society, while working on improving efficiency within our own company.

I wish you a safe and successful 2022.

Best regards,

TOMOAKI FUKUHIRA
Senior Vice President & CFO
Canon Medical Systems Europe

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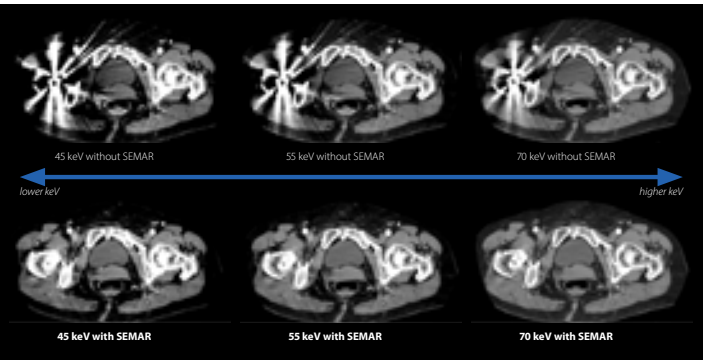

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“Spin To The Limit - MRI Principles & Physical Challenges”: The reference book on MR Imaging

This unique portrait of MRI, designed with more than 40 international experts, is now available for free!

Olea Medical (Canon Medical Group) has just published its reference book on MR Imaging. “Spin to the limit - MRI Principles & Physical Challenges” provides a complete overview regarding the past, the present and the future of MRI, this unmatched imaging modality holding a central position in the forthcoming medical revolution.

Originally available in English, but soon in French and Japanese, the book is the result of an outstanding work carried out by Olea Medical teams, for over a year and a half, under the editorial direction of the Clinical Affairs department.

“Historically, our company has been built around strong partnerships with leading academic research centers, university hospitals and experts from the medical world”, says Fayçal Djeridane, CEO of Olea Medical. “This book has been designed on the same principle, with the contribution of more than 40 opinion leaders from numerous fields of medical imaging”.

The 300-page book, without ever losing the objective of educational vocation, is composed of four complementary chapters revealing the exceptional and never-ending MRI story. They are structured through 50 papers written by clinicians, researchers and engineers, who kindly accepted to share their outstanding expertise. Additionally, 180 MRI stories were collected from international experts who, through their clinical and research practice, present their visions, their hopes, their intuitions as well as their avenues for deploying the means necessary for innovation.

“At Olea Medical, we believe that knowledge is free and should be shared”, explains Fayçal Djeridane. “We are therefore proud to make it available to all, free of charge: radiologists, physicians, technologists, students, learned societies and curious minds”. //

Canon Medical Systems UK off the Starting Blocks for Birmingham 2022 Commonwealth Games

Building on a decade of sports medicine partnerships to elite sports and Premier League football, Canon Medical Systems UK will be Presenting Sponsor - Birmingham 2022 Commonwealth Games' Polyclinics.

Canon Medical UK will provide the very latest medical imaging modalities including AI-assisted health IT connectivity and MRI, diagnostic ultrasound and digital radiography X-ray with full health IT connectivity.

The Polyclinics will provide early detection, prevention and faster rehabilitation of sports injury and surveillance. They will be located at three locations for three weeks across the Birmingham 2022 Athletes Villages to support 4,500 athletes from 72 nations and territories.

Ian Reid, CEO at Birmingham 2022, said: "We're delighted to be working with Canon Medical UK as part of their partnership as our Official Imaging Supporter for Birmingham 2022 and are in no doubt that their industry-leading medical imaging technologies will help make the Birmingham 2022 Commonwealth Games this summer's biggest sporting event. Using Canon Medical's global expertise, the Sports Imaging Hubs will be an incredible resource for our athletes to help detect or prevent sports injuries, offering the very latest medical facilities for world-class athletes."

Canon Medical UK will work in synergy with Canon EMEA to provide their exceptional image-quality technologies to support the Birmingham 2022 Commonwealth Games. From cameras to print hardware and medical imaging: every system provided will enhance the clarity of the sporting event. //

Left to right: Adrian Corcoran, Chief Information Officer, Birmingham 2022 Commonwealth Games, Ian Reid, Chief Executive Officer, Birmingham 2022 Commonwealth Games, Peter Raper, Commercial Partnerships Project Director, Birmingham 2022 Commonwealth Games and Vice President - Major Events and Strategy, Sport Five, Yuichi Ishizuka, President & CEO, Canon EMEA, Ian Watson, Director of Commercial Solutions, Canon Medical Systems UK, Mark Hitchman, UK Managing Director, Canon Medical Systems UK.

Customer Survey Award Integron

Canon Medical Systems Europe is the winner of the Customer Experience Awards 202 in the category ''Continuous Customer Feedback''!

Integron presents annual awards to organizations that score well in the areas of customer and employee satisfaction. A total of 41 organizations were nominated in 16 categories. Last year's Experience Awards did not take place due to COVID-19 measures.

The nominees and eventual winners come from the hundred of customer and employee experience surveys conducted by Integron in 2019 and 2020. This award is based on the highest average Net Promoter Score (NPS).

See on pages 58-59 the overall European customer's results of Canon Medical in 2021. //

Canon Medical Systems Australia - Winner of the 2021 MTAA Kerrin Rennie Award

The Kerrin Rennie award recognizes the innovative and extraordinary contribution of medical technology in improving health outcomes for Australian patients. The MTAA is the Medical Technology Association of Australia, and this award is one of MTAA's most prestigious awards. We are proud to announce Canon Medical Systems ANZ Pty Limited as the winner of the 2021 MTAA Kerrin Rennie Award.

Canon Medical have introduced the world's first high-definition (Hi-Def) flat panel detector for use in image-guided endovascular procedures. The Hi-Def panel is available on the Alphenix range of interventional imaging systems and with its 76 micron pixel imaging mode, provides more than twice the spatial resolution of conventional flat panel detectors.

With the highest level of resolution available in the angiography market, the innovative Hi-Def technology allows clinicians to perform minimally invasive procedures with clear images to see fine details, enabling them to prioritize clinical decisions and patient outcomes. //

Offline Analysis Made Easy

Canon's new UltraExtend NX workstation helps you turn clinical data into actionable insights

Organizing and managing clinical data can be challenging, especially when it is collected alongside your daily routine. Canon's UltraExtend NX is a simple solution to organize and track cases in an efficient, yet affordable manner.

Compatible with the Aplio i- and a-series, UltraExtend NX offers a complete workflow from organizing, reviewing and analyzing clinical data to documenting and reporting results. UltraExtend NX allows you to work with a variety of network situations. The software can, for instance, fetch data directly from your ultrasound machine and local NAS*; or send your results to your departmental PACS. //

Scan or click on the QR code for more information

**NAS: Network Attached Storage; not included*

Canon Medical's New Vantage Fortian Redefines Workflow and Productivity

Canon Medical has launched a new 1.5T MR system, The Vantage Fortian. The new system, which was revealed at RSNA 2021 in December last year, has been developed to provide increased ease-of-use and efficiency with no compromise on image quality.

The Vantage Fortian is designed to improve MR workflow and productivity further than ever by addressing challenges from a wider perspective. It has been developed in response to feedback from a wide range of MR stakeholders from management to technologists and radiologists.

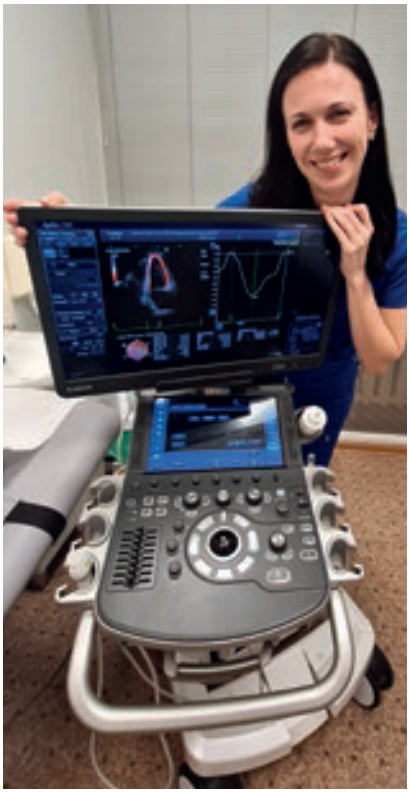
The new system introduces a new App for tablets that enables technologists and radiologists to take the MR console everywhere inside the hospital. The App streamlines patient preparation and scanning monitoring processes. The MR operator can verify patient demographic and clinical information to select and modify the right protocol on the spot. The App sets a new standard in MR safety by incorporating the latest patient information directly prior to scanning.

Scan automation and precise planning take a new approach with the addition of the Ceiling Camera. The Vantage Fortian guides the operator for optimal coil positioning and automatically moves the patient to the iso-center. The Ceiling Camera will help to avoid patient positioning errors and streamline the process of patient positioning from the first step. Auto Scan Assist technologies automate the planning process once patient is inside the bore.

Operational efficiency is further improved with the latest versions of Canon Medical's scanning acceleration techniques. Compressed SPEEDER, Advanced intelligent Clear-IQ engine (AiCE), Fast3D, and Iterative motion correction will enable faster scanning with no compromise on image quality. //

Scan the QR code or click HERE for more information.

First Canon Medical Dedicated Cardiology Ultrasound System in Latvia



The first Canon Medical Aplio i700 Prism Edition in Latvia was successfully installed recently at private health clinic chain, Heath Center 4 (HC4), in Latvia.

The new cardiology system has already brought improvements in image quality, workflow and automated features.

HC4 is one of the largest and most advanced multi profile private health care clinics in Latvia. With more than 20 facilities across the country, it already has a significant installed base of Canon Medical Ultrasound, which is used mainly for general radiology and shared services.

Specialists in the chain were looking for a new Cardiology Ultrasound system and after a demonstration with Canon Medical's new Aplio i700 Prism Edition they were pleasantly surprised at the results achievable. The specialists who tested the system were most impressed with the system's image quality in 2D, Automated Measurements and 2D WMT (2D Wall Motion Tracking) software.

"This is the first Canon Medical dedicated Cardiology Ultrasound system to be installed in Latvia, and we know it won't be the last one!" remarked by A. Medical, Partner of Canon Medical Systems Europe and Eva Rubene, European Clinical Specialist Ultrasound, Channel Partner Network. "Our name is very well known in the Latvian radiology community thanks to the superior image quality of Canon Ultrasound systems." //

Canon
CANON MEDICAL

Made For life

Intelligent healthcare made easy

Introducing Altivity, our bold new approach to AI innovation that uses smart technologies to make a whole new level of quality, insight and value across the entire care pathway, possible.

Informed healthcare

Altivity is here to help enhance your clinical confidence with high-quality images and integrated data that help you make informed decisions in real-time, at the point of delivery.

Fast, tailored care

Altivity has been created with your patients in mind, to deliver the fast and accurate results they need with a more personalized approach.

Efficient workflows

Altivity helps create simple, streamlined AI-driven workflows that optimize resource deployment and ensure your teams have the insights they need to work smarter every day.

Please visit the Canon Medical website for more detail:
https://eu.medical.canon/specialties/ai/

CANON MEDICAL SYSTEMS EUROPE B.V.
https://eu.medical.canon/

"Introducing AItivity – Redefining the Role of AI in Healthcare"

One of the greatest things about the healthcare industry is the sheer speed at which it seems to evolve. I'm constantly amazed by the passion, dedication, and expertise demonstrated by our leading healthcare innovators, particularly in the area of AI.

Just recently, Canon Medical launched its bold new approach to AI innovation…Altivity. We are extremely proud of this development, as it consolidates our range of deep learning and machine learning technologies to help clinicians deliver better outcomes to their patients and their business. If nothing else, the last twelve months have shown to us how adaptable and ready for change we need to be. The strain placed on healthcare systems by COVID-19 has pushed clinicians to their limits. Incidences of cancer, heart disease, and stroke are rising. And the increasing complexity of patient data is creating new opportunities that could easily be missed without insights and guidance from the right technology.

For many, these issues represent overwhelming challenges that are too difficult to resolve or require too great an investment. For us, however, we see them as opportunities for growth. At a time when resources are limited, we are doing everything we can to help our customers deliver informed healthcare with efficient workflows, so their patients can access the tailored treatment they need. And we are doing it with the power of AI.

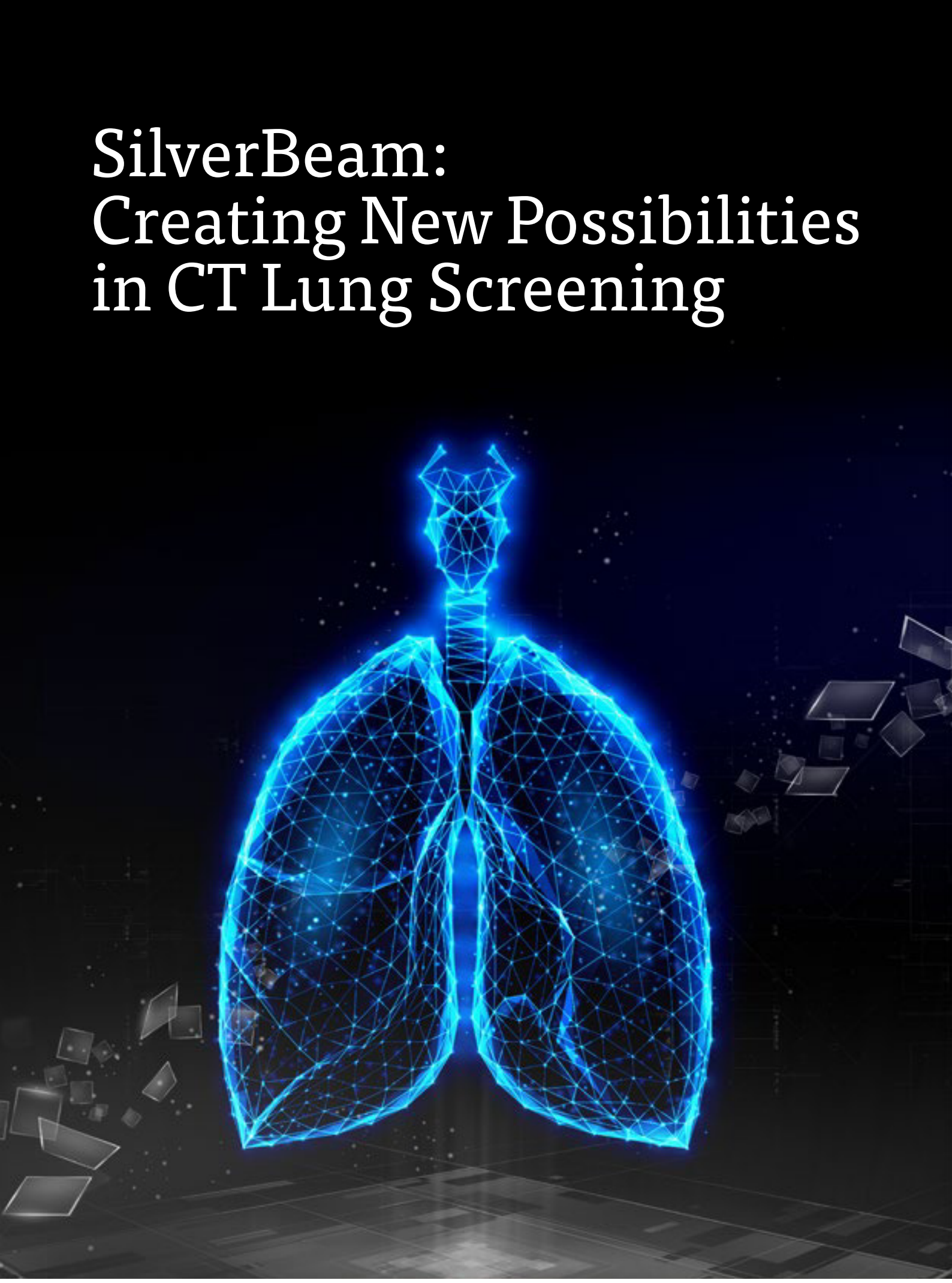
Canon Medical has been steadily redefining the role of AI in healthcare, starting with our Advanced intelligent Clear-IQ Engine. Initially developed for CT, Canon Medical quickly deployed this Deep Learning Reconstruction technology across MRI and PET-CT systems to help speed up scan times and improve image quality. Next, came the launch of Automation Platform and the AUTOStroke solution, both of which were designed to enhance clinical confidence and streamline workflows with the power of deep learning technology.

More recently, Canon Medical has transformed the ultrasound space with AI innovations, available in certain regions that revolutionize clinical workflows. Through leveraging the power of AI, Canon Medical has been able to automate standardized serial measurements to drastically increase clinical productivity and reporting accuracy.

As ever, our vision is to build a future where every individual receives the diagnosis and treatment that they need to live their lives to the fullest. While this won't happen overnight, I know that it starts with systems and solutions that are "Made for Life".

TOSHIO TAKIGUCHI
President and Chief Executive Officer
Canon Medical Systems Corporation

SilverBeam: Creating New Possibilities in CT Lung Screening



Canon Medical introduced SilverBeam, a beam shaping energy filter that delivers AI enhanced, high quality, low noise CT images optimized for lung screening. With continued high demand for chest CT, as well as interest in many countries in establishing national screening programs to detect lung cancer early, the new filter is being welcomed by specialists all over the world. Dr. Marcus Chen, Director of Cardiothoracic Imaging at the National Institutes for Health (NIH), Maryland, US, was involved in the development of SilverBeam. He explained to VISIONS how SilverBeam is a 'game-changer' in ultra-low-dose lung imaging.

SilverBeam Filter works to remove low-energy photons from the beam spectrum, which do not contribute to image quality but do increase dose and scatter. SilverBeam selectively optimizes beam energy.

When combined with Canon Medical's Advanced intelligent Clear IQ Engine (AiCE) technology, this beam-shaping energy filter can harness the power of AI to deliver high resolution and low noise for applications such as lung screening.

"The NIH has been working with Canon Medical on SilverBeam technology since October 2021," said Dr. Chen. "SilverBeam is a filter that is applied to the X-ray spectrum to better visualize the lungs but, at the same time, to reduce the X-ray dose and to work in conjunction with deep-learning reconstruction. So, with SilverBeam, we are better able to see the lung parenchyma."

"The images we can obtain are sharper especially in the soft tissue, as SilverBeam reduces noise. We're now able to see more solid details such as ground-glass opacities, which can otherwise be difficult to visualize, and we can more accurately measure lung nodule sizes," he added.

"Overall, we're able to significantly reduce the radiation dose, which improves patient safety."

Innovative collaboration

NIH has collaborated with Canon Medical for more than a decade towards improving CT technology and image quality across many applications.

"Over the past twelve years, we have had five different Canon Medical CT scanners," Dr. Chen reflected. "In 2009, we invested in the Aquilion ONE, because we felt that the best way to image the heart was to image it in one heartbeat with the Aquilion's wide volume technology. This proved very advantageous. In 2015, we hosted the prototype ultra-high-resolution CT system with four-times the resolution of a normal CT scanner, and slice thickness of 0.25 mm. In 2020, we upgraded to the Aquilion ONE / PRISM Edition, which has spectral imaging."

Game-changer

Designed to work in combination with AiCE, SilverBeam delivers AI enhanced, high quality, low noise CT lung cancer screening images at the radiation dose on the order of a typical chest x-ray exam.

"Overall, I am very excited by the SilverBeam Filter," said Dr. Chen. "It improves image quality and reduces the amount of image noise. What I'm most excited about is how much it's able to reduce the radiation dose, while preserving overall image quality and diagnostic accuracy."

"Now, we are able to offer ultra-low dose chest for lung cancer screening. That's a game-changer!"

Dr. Marcus Chen, Director of Cardiothoracic Imaging at the National Institutes for Health (NIH), Maryland, US .

How important is lung cancer screening?
In 2020, lung cancer was of cancer death worldwide, causing an estimated 1.8 million deaths[1]. Studies have shown that screening with low dose CT for high-risk individuals can help diagnose cancer early when successful treatment is more likely.

A short history of lung cancer screening
Screening people without symptoms for early signs of lung cancer began in the 1950s with chest X-rays to find early lung tumors in groups of men in the 1950s, but due to disappointing results lung cancer screening was put on the backburner.

In 1977, the first CT study scans to look for lung cancer was published[2]. Computing power combined with x-rays meant the lungs could be seen in more detail than before, but the amount of radiation that patients were exposed to in a CT scan was much higher than traditional chest X-rays.

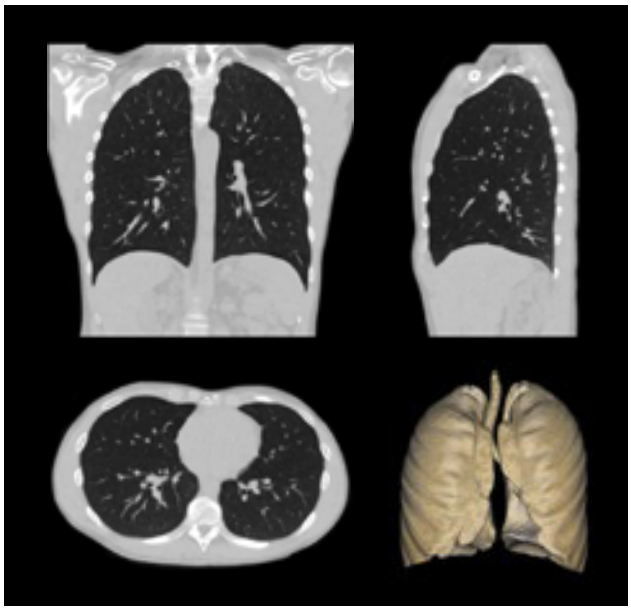
In 1996, researchers showed that newer CT scanners using a lower radiation dose, were better at detecting abnormalities.[3]

In 2002, a large-scale trial - the National Lung Screening Trial (NLST) - was started in the US. It involved more than 50,000 people at high risk for lung cancer, who were screened annually for three years, using either a chest X-ray or the low radiation dose CT scan. The results showed around a 20% reduction in the number of lung cancer deaths in the group monitored with the low dose CT scans compared to X-rays. The results were published in 20114 and one death from lung cancer was avoided for every 330 people screened with low-dose CT compared to an X-ray.

Now, various countries are looking into introducing some form of national screening for lung cancer in high-risk patients.

The dose is reduced by enough to enable specialists to reassure any patients who might be reluctant to have a scan due to concerns about exposure to radiation.

"I have had patients who are reluctant to come in for a chest CT because of the fears of radiation," said Dr. Chen. "However, now with the SilverBeam Filter, that barrier is removed. And now, we are able to offer ultra-low dose chest CT for screening for lung cancer. That's a game-changer!" //

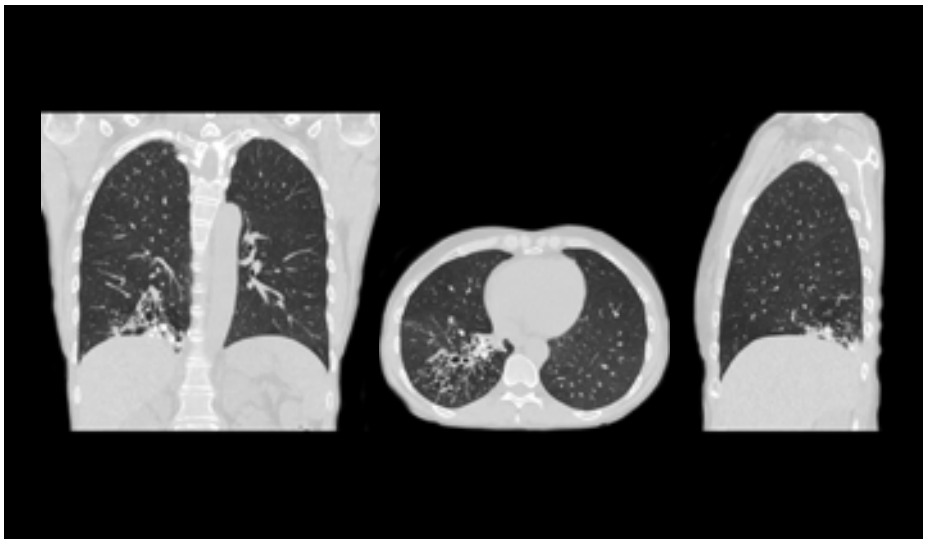


CT Lung acquired with SilverBeam technique, $CTDI_{vol}$ 0.4 / DLP 18.7.

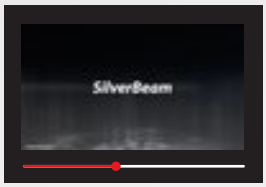
Read more about SilverBeam:
https://eu.medical.canon/products/computed-tomography/aq_one_prism_features-benefits#silverbeam

References

[1] *Insert reference from presentation.*
[2] *https://pubmed.ncbi.nlm.nih.gov/865129/*
[3] *https://pubmed.ncbi.nlm.nih.gov/8939234/*
[4] *https://pubmed.ncbi.nlm.nih.gov/21714641/*



CT Lung acquired with SilverBeam technique, $CTDI_{vol}$ 0.6 / DLP 24.5.



Scan the QR-code or click HERE to watch the video

Exploring the Retina as a Window to the Brain

Some major neurological disorders that are difficult to diagnose and assess by MRI in their earliest stages, produce certain indications in the eye. This provides diagnostic opportunities for special- ists. One important example is multiple sclerosis (MS). Optical coherence tomography (OCT) can be used to assess the retinal damage caused by MS as a marker for the wider neurodegenerative process that occurs inside the whole brain in MS. Neurologist and MS expert, Professor Bart Van Wijmeersch, leads the University MS Centre in Pelt, Belgium. He explained to VISIONS how OCT imaging can help in determining MS-prognosis, treatment options and follow-up.

Multiple sclerosis (MS) is a lifelong autoimmune condition that affects the central nervous system. At the start of the disease, some lesions are produced inside the brain and can cause an initial symptom. This is categorized as a clinically isolated syndrome. When it repeats itself, it becomes known as relapsing-remitting MS, and later on, it can progress into other forms, such as progressive-MS. On a cellular level, MS develops through a combination of inflammatory lesions, and simultaneous axonal loss and demyelation, which cause neurodegeneration and brain atrophy.

Optical coherence tomography (OCT) is a fast and noninvasive imaging technique that is used to map the layers of the retina. This technology is used in many medical specialties beyond ophthalmology, such as cardiology and research.

A challenge to diagnose

MS can progress below a clinical thresh- old for many years without the patient noticing and prove difficult to diagnose. While it can be used to detect lesions over time, MRI is not always 100% reliable in detecting all lesions inside the brain.

Canon Medical Eye Care

Alongside its reputation as a leader in MRI, CT and Ultrasound technology, Canon Medical is becoming increasingly recognized in ophthalmology for its range of high-quality eye care imaging systems. Canon's ophthalmic diagnostic equipment includes digital retinal imaging systems, OCT systems, and other ophthalmic measurement instruments, as well as associated intuitive advanced ophthalmic software to enhance patient workflow and diagnostic reporting.

"Cortical grey matter lesions, in particular, do not show up well on MRI," remarked Prof. Van Wijmeersch. "Even though double inversion recovery (DIR) is already somewhat better, around 80% of these cortical lesions are not seen."

First indications

The optic nerve is one of the three key areas most often initially affected by MS, alongside the brain and spinal cord, and optical neuritis can be one of the first indicators of the disease. Optical coherence tomography (OCT) is used to image and measure the different layers of the human retina and can provide detail on any retinal damage caused by MS.

"Around 80% of MS patients have atrophy in the retinal nerve fiber layer and ganglion cell layer of the retina and 40% of patients have problems with the inner nuclear layers of the retina," explained Prof. Van Wijmeersch. "With OCT there is the possibility to examine these layers in detail, in real life."

Important assessment tool

OCT can be used in MS assessment in three ways: diagnosis, prognosis and follow-up of treatment.

"Using OCT in a diagnostic way for MS is not so surprising, because one of the first symptoms of the condition is optic neuritis, but it can also be used on a prognostic level, and in follow-up of treatments or follow-up of these patients over time," said Prof. Van Wijmeersch.

"I think this is the most promising contribution that OCT makes in MS assessment, and I believe that it can have a very big impact in clinical practice."

"What happens on the retina mirrors what happens inside the brain in MS," he continued. "Studies have shown that atrophy in the brain over time due to MS correlates very much with loss of retinal nerve fiber layer thickness over time. So, the smaller that is, the more atrophy there is."

Longer term monitoring

Detecting progression of MS and neurodegeneration before the patient is affected by it can offer the possibility for treatment that can slow the loss of neurons and even restore some of the damage caused by the disease.

"The prognostic relevance of retinal fiber layer thinning is particularly important. A very low retinal nerve fiber layer means that the patient already has a lot of brain damage and has less brain reserve, which leads to a worse prognosis in MS," said Prof. Van Wijmeersch. "When patients who present initially with a retinal fiber layer that is thinner than 87 or 88

Prof. Bart Van Wijmeersch is a Neurologist specialized in Multiple Sclerosis (MS). He is the Medical Director of the University MS center in Pelt, Belgium, where he leads a multidisciplinary MS-team. He is also an Associate Professor of Neurology at the University of Hasselt, also in Belgium, where he's involved in pre-clinical, as well as clinical research on MS. He has a supporting role in all the immunological research on blood- and CSF samples of people with MS and in EAE-animal models, as well as in the clinical rehabilitation research (BIOMED & REVAL). Immunological, Biomarker, MRI, Electrophysiological and Rehabilitation research in MS come together in this way. He has an educational role in the Faculty of Medicine and Physiotherapy at the University.

Prof. Van Wijmeersch is a member of the Belgian Study Group of Multiple Sclerosis and a member of advisory boards of different pharmaceutical companies with interest in MS. He was co-founder and the first President of the ParadigMS Foundation - an organization dedicated to education on MS to improve the everyday clinical care of people with MS. As an acknowledgment of his scientific work, he received an honorary award from the Flemish Government in 2019.

"OCT is a real tool for the future."

Professor Bart Van Wijmeersch, Medical Director of the University MS center in Pelt, Belgium.

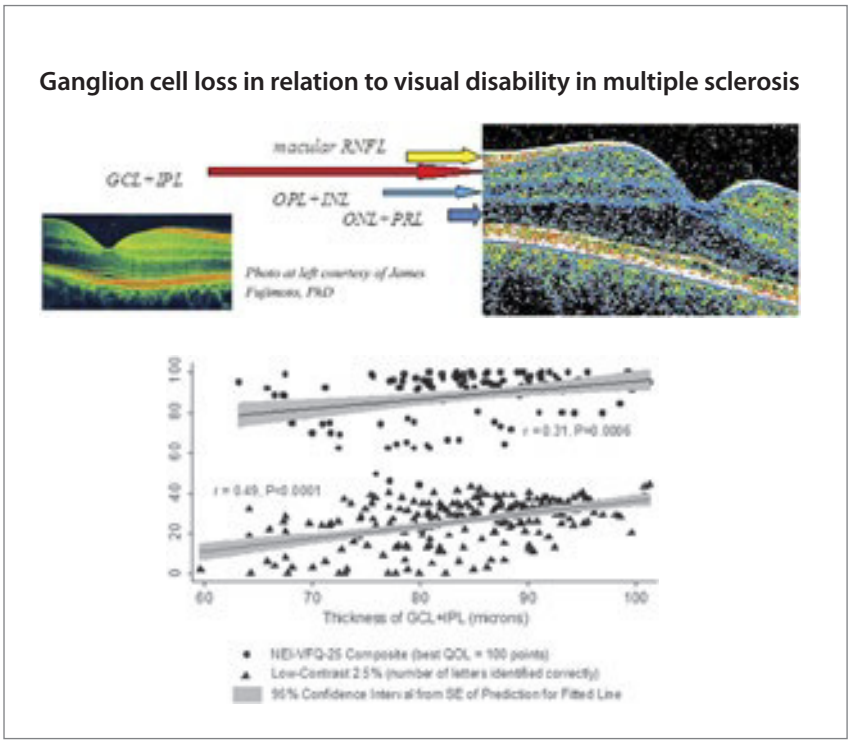


Figure 1: OCT and conventional MRI

microns are re-examined two-years later, there can be a doubled risk of having increased disability. Three to five years later, and that risk can be fourfold."

Tool for the future

Predicting the progression of MS, independent of relapses, is something that remains very hard to achieve, because there has been a lack of good biomarkers for neurodegeneration.

'Using OCT to map changes in the retinal nerve fiber and ganglion cell layer can help as a baseline for prognosis, in guiding your treatment choices, and also follow up on patient treatment responses in MS. I think it's a real tool for the future." said Prof. Van Wijmeersch.

Studies into the use of OCT in MS diagnosis and treatment continue to find out more about their scope in a clinical setting. //

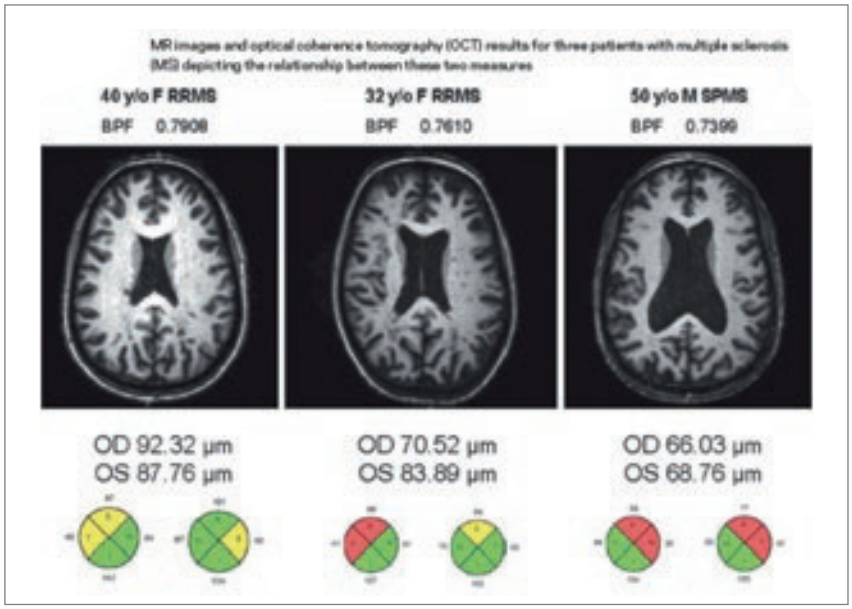


Figure 2: Retinal nerve fiber layer (RNFL) thickness

Canon Medical OCT

Canon Medical has recently developed and launched Xephilio - a new generation of OCT using AI empowered technology combining Japanese craftsmanship with latest Canon imaging solutions.

This is embodied in two new OCT systems:

Xephilio OCT-A1

A fully automated OCT with unsurpassed image resolution for fast and efficient eye examinations. SLO based technology the Xephilio OCT-A1 is allowing efficiency and patients' comfort during the few minutes' patient examination.

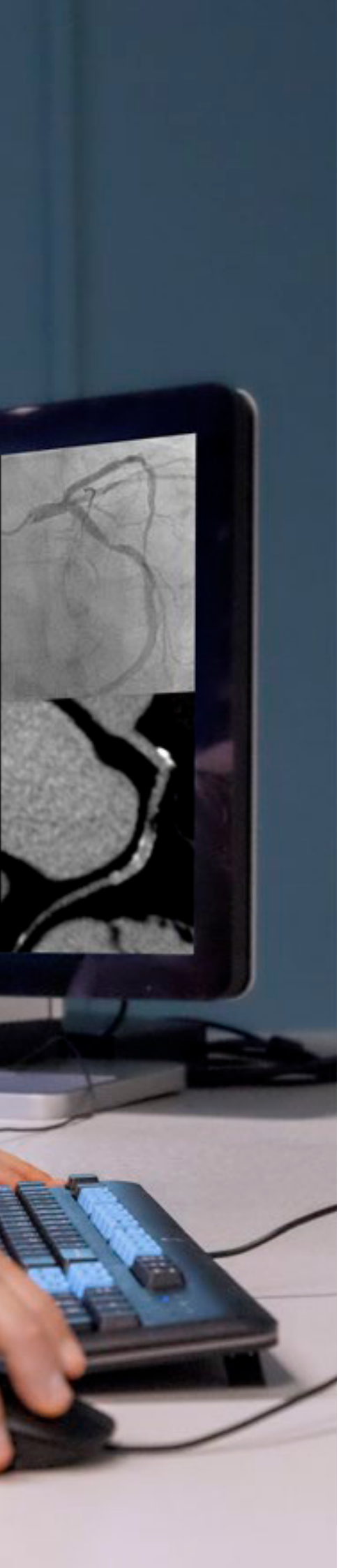
Xephilio OCT-S1

Xephilio OCT-S1 features Canon Medical's revolutionary swept source technology, which allows the user to capture in a single acquisition wide-field images of up to 23 mm with 5.3mm depth. Xephilio OCT-S1 fast acquisition up to 100,000 a-scan per seconds combined with a longer wavelength of 1,060 microns enables superior penetration of eye opacities and dense objects while providing outstanding tomographic and OCT Angiographic images.

Read more on studies carried out with OCT from Canon Medical:

Birkeldh et al. | Retinal nerve fiber layer thickness associates with cognitive impairment and physical disability in multiple sclerosis | Multiple Sclerosis and Related Disorders (2019)

Birkeldh et al. | The Temporal Retinal Nerve Fiber Layer Thickness Is the Most Important Optical Coherence Tomography Estimate in Multiple Sclerosis | Frontiers in Neurology (2017)



VISIONS spoke with Dr. Olivier Ghekiere, a global expert in the field of cardiac imaging. He works with both cardiac CT and MRI at the Radiology Department of Jessa Hospital, Hasselt, Belgium.

A Dynamic Solution for Streamlining Cardiac Diagnosis

Dr. Olivier Ghekiere is a global expert in the field of cardiac imaging. He works with both cardiac CT and MRI at the Radiology Department of Jessa Hospital, Hasselt, Belgium. In the past 10 years, his research has included exploration of the technical shortfalls in cardiac CT Angiography (CTA). Now, the Dynamic Myocardial Perfusion application with Canon Medical's Vitrea Advanced Visualization closes a gap in diagnostic possibilities in cardiac CT and enables significantly streamlined workflows.

Boosting cardiac diagnostics

Coronary CTA requires additional functional evaluation for stenosis to guide therapeutic management. Much of the research that Dr. Ghekiere has carried out has investigated options for the non-invasive management of intermediate coronary stenosis, including quantitative coronary CTA and stress perfusion cardiac Magnetic Resonance (CMR). He was awarded Magna cum laude for his scientific work entitled: "Technical Pitfalls in cardiac CT angiography: What the radiologist should know." at the 2012 ESCR annual scientific meeting, held in Barcelona, Spain, and at the 25th anniversary 2019 ECR congress in Vienna, Austria.

"CTA is poor in predicting ischemia, mainly in intermediate coronary artery stenoses. However, the presence or not of ischemia determines treatment and whether that is by medication or by revascularization," he explained. "CT Dynamic Myocardial Perfusion gives an additional functional assessment of the coronary stenosis on top of the anatomical information (CTA). It enables us to offer a 'one-stop-shop' in CT for the patient – a single CT examination with anatomic and functional information to guide treatment. This means that the patient doesn't have to come to the hospital twice for diagnosis."

"We appreciate Vitrea Advanced Visualization particularly, because of its quick workflow, robustness and good centerline tracking of the vessels."

Dr. Olivier Ghekiere,
Global expert cardiac imaging, Radiology Department of Jessa Hospital, Hasselt, Belgium.

Dr. Olivier Ghekiere

Dr. Ghekiere graduated as doctor in 2001 at the KU Leuven, Belgium and obtained his specialization as a radiologist in 2006 at the UCL St.-Luc, Belgium. He further specialized in cardiac imaging and obtained, among other things, the LEVEL 1 and LEVEL 2 diploma from the American College of Cardiology (ACC) for Coronary CT Angiography (CVCTA Education, San Francisco). In 2018, he obtained the European Diploma in Cardiovascular Radiology (European Board of Cardiovascular Radiology).

Dr. Ghekiere has worked at the Radiology Department of Jessa Hospital, Hasselt, Belgium, since January 2015. He has specific skills in cardiac imaging (CT and MRI).

Since 2018, he has also given guest lectures at Hasselt University, and since 2021, has been guest professor at the Hasselt University, Belgium.

Since 2012, he has been actively involved in the cardiological support of the Lotto-Belisol and Lotto-Soudal cycling teams, and since 2017 with the Trek Baloise cycling team. He organized various conferences on sports cardiology in collaboration with these cycling teams since 2014.

Dr. Ghekiere is the author of more than 20 scientific publications in international journals and has given numerous scientific presentations on various cardiac topics at national and international conferences.

He received a Magna cum laude for best scientific poster at the European Society of Cardiac Radiology (ESCR) congress in Barcelona 2012 and Milan 2017, and at the European Congress of Radiology in Vienna 2019.

Professional memberships:

Board member of the Belgian Society of Radiology (BVR) since 2012.

Charmain of Working Group Medical Imaging of the Technical Medical Council of the RIZIV/INAMI, Brussels since 2020.

Member of the Technical Medical Council of the RIZIV/INAMI, Brussels since 2013.

Member of the Belgian Medical Imaging Platform (BELMIP), FPS Public Health, Brussels since 2011.

Board member of the Belgian Association of Physicians Syndicates (BVAS) since 2015.

The standardization of the application and workflow of Vitrea's CT Dynamic Myocardial Perfusion leads to low inter user variability. The automated results for Myocardial Blood flow (MBF) for stress and rest and Coronary Flow Reserve (CFR) enable the clinician to make the clinical decision between revascularization versus medical treatment in a patient with an obstructive coronary artery stenosis.

Advanced suite

Jessa Hospital has invested in a suite of advanced CT equipment from Canon Medical including an Aquilion ONE ViSION, Aquilion Lightning SP with Advanced intelligent Clear-IQ Engine (AiCE), powered by Altivity (Canon Medical's AI suite of technologies). Vitrea Advanced Visualization is currently used for cardiac examinations.

"Canon's systems are robust, and bring us easier and faster workflow," said Dr. Ghekiere."Optimal workflow is a necessity for our department and patient care, especially to ensure that complex examinations receive the best diagnostic evaluation."

"We appreciate Vitrea Advanced Visualization particularly, because of its quick workflow, robustness and good centerline tracking of the vessels," he continued. "There's a good standardization of the application and an easy workflow. This leads to a low variation between different operators."

Next steps

The next challenges in Cardiac CT are the integration of artificial intelligence and further improvements in temporal and spatial resolution for similar image quality of conventional coronary angiography and less radiation dose.

Combined with the increase in computing power, AI might help speed up treatment and patient management and deliver essential information for the interpretation of CCTA exams. //

What is Vitrea's solution?
CT Dynamic Myocardial Perfusion enables the visualization and analysis of perfusion deficits in the myocardium.

It features:

- *Automatic stress and rest series recognition.*
- *Multiple review layouts.*
- *Accurate calculation of multiple parameters, including myocardial blood flow (MBF).*
- *Multiple polar map options including AHA vessel segments and AHA 17 segment maps. Overlay polar maps with coronary tree and vessel territory for anatomical referencing when assessing perfusion defects.*
- *Import coronary snapshots from other Vitrea applciations, allowing the accurate analysis of the coronary arteries and myocardium.*
- *Coronary arteries can be projected onto poler map. This enables visualization of the myocardial region correlated with supplying coronary arteries on polar map.*
- *Vessel marking function - Vessel marking on a coronary artery provides the myocardial region correlated with supplying coronary artery from the marked point to distal on polar map. By specifying this point on coronary artery, it is also possible to calculate the partial myocardial mass of the region involved.*
- *Fusion View. Fusion of perfusion map onto 3D heart and coronary tree images.*
- *Batch saving (3D, MPR).*

Its key benefits are:

- *Automatic left ventricle and myocardium segmentation.*
- *Quantifiable results of the MBF and Coronary Flow Reserve (CFR).*
- *Polar map plots of Stress and rest MBF and CFR highlighting potential myocardium defects.*
- *Ability to calculate the partial myocardial mass affected by a diseased coronary vessel.*
- *Fusion view of coronary vessel branches on the polar maps.*
- *Fusion of the polar maps on the 3D heart rendering.*

Surviving the COVID-19 Pandemic– Long Term Perspectives

Professor Joao A C Lima,
MBA MD, Professor of Medicine, Director of Cardiovascular Imaging, Johns Hopkins University, Baltimore, US.

As we continue to fight the COVID-19 pandemic, health professionals all over the world are not only still dealing with cases of acute COVID-19, but also patients with long term problems associated with the virus. COVID-19 infection can damage the lungs, heart and brain. High-quality imaging in all modalities is essential for diagnosis, monitoring, treatment and follow-up of both COVID-19 and post-COVID-19 patients. The state-of-the art features of Canon Medical's range of imaging solutions are proving invaluable in research and management of COVID-related changes. Some of the world's leading physicians shared their latest findings on imaging and treatment outcomes for these patients in a Canon Medical webinar that was Chaired by Professor Joao Lima from the Johns Hopkins University, Baltimore, US.

The effects of COVID-19 on the lungs became immediately obvious in the pandemic. Now, there is considerable focus on what happens to the lungs as people convalesce and survive COVID-19. Chest CT emerged right at the beginning as the modality of choice for COVID-19. It has already proved very useful in acute conditions for positive and differential diagnosis, for risk stratification, and for follow-up of acute complications, including Pulmonary Embolism (PE), superinfection, acute respiratory distress syndrome (ARDS). CT is now under consideration for longer term follow-up of fibrosis.

It is considered usual to find persistent abnormalities at three-months after initial infection. Professor Mickaël Ohana, Consultant Radiologist at Strasbourg University Hospital, Strasbourg, France, explained findings from one of Europe's most intense COVID-19 clusters.

"Our institution was essentially a 'COVID-19 hospital' for at least three months. Together with our pulmonologists, we prospectively monitored patients that were hospitalized for the disease with comprehensive respiratory follow-up at three- and six-months that included a Chest CT," he explained. "More than two thirds of patients had abnormal Chest CT at three-months, but only 50% had persistent abnormalities at six-months. The persistent abnormalities at six-months were seen only in patients who initially had critical disease, and they were rated as minor.

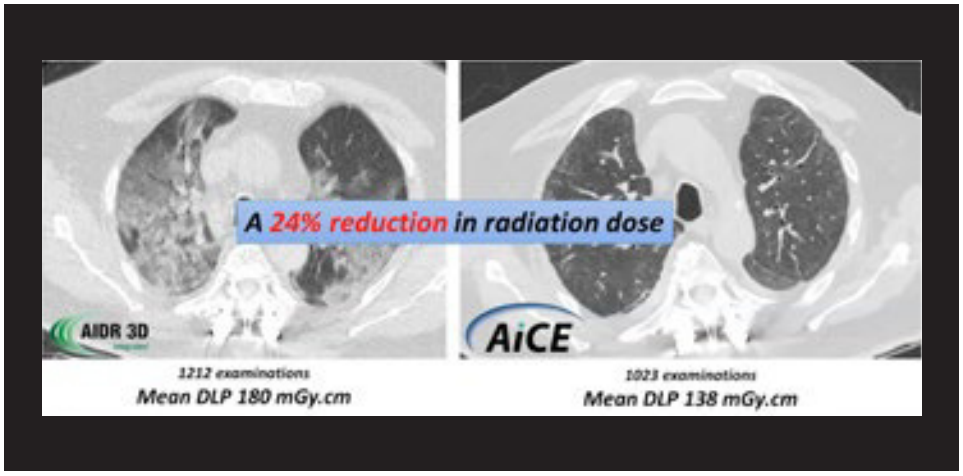


Figure 1. Impact of Deep Learning Reconstruction (AiCE) compared to Hybrid Iterative Reconstruction on chest CT, resulting in a radiation dose reduction of 24%.

Professor Mickael Ohana,
MD PhD, Consultant Radiologist, Strasbourg University Hospital, Strasbourg, France.

The lesions were mostly peripheral: parenchymal bands, bronchiectasis, honeycombing - and are mostly limited in their lung parenchyma extension. They rarely seem to extend over 10% of the total lung parenchyma. No oxygen therapy was required among the patients after their initial COVID-19 episode. Symptoms in these patients are usually quite rare."

"It looks like there could be a disconnection between the physiology and clinical evolution, which looks relatively and surprisingly good," he added. "Follow-up Chest CT should not be carried out before six-months after discharge, otherwise, it's too early, and you will find lesions that you will not know what to do with."

It is essential that radiation dose is adequately optimized in these patients with the lowest dose possible. This is possible due to Canon Medical's Deep Learning Reconstruction technology, Advanced inteligent Clear-IQ Engine (AiCE) ensuring the highest IQ with lowest dose. AiCE is powered by Altivity; AI innovation that uses smart technologies to make a whole new level of quality, insight and value across the entire care pathway possible.

"In 2020, we carried out around 1,000 examinations with an iterative reconstruction technique. We also performed about 1,000 examinations with the exact same acquisition parameters, but with AiCE, and we managed to achieve a 24% reduction in radiation dose, without doing anything more. This technology is very, very efficient," remarked Professor Ohana.

Comprehensive scanning for effects on multiple organ systems

Although pulmonary findings are the most well-known presentation, COVID-19 infection affects multiple organ systems. Therefore, beyond Chest CT, comprehensive imaging exam of convalesced patients on MRI without ionizing radiation may be helpful for the risk stratification and adequate follow-up of patients with Post-COVID conditions.

The Johns Hopkins School of Medicine, Johns Hopkins University in Baltimore, US, has developed a comprehensive COVID-19 MRI protocol, which includes brain, lung, heart and liver. It uses a one-hour scanning protocol, which consists of non-contrast and post-contrast imaging.

"We aim to characterize the cardiopulmonary consequences in individuals who required hospitalization for COVID-19, using state-of-the-art CT and MRI from Canon Medical," said Dr. Yoko Kato, Post-doctoral Fellow Cardiovascular Imaging. "We first scan the brain, and then move on to the liver and heart (non-contrast images) and after that, we acquire the lung perfusion images following administration of Gadolinium contrast. And after use of the remaining dose of the contrast, we acquire the post-contrast lung UTE, as well as cardiac MRI images. We acquire diffusion images (DTI) and flow-sensitive black blood (FSBB) images for the best vasculature assessment. MP RAGE (Magnetization Prepared - RApid Gradient Echo) for the brain volume and structural assessment and T1, T2 and T1-wall mapping for the tissue characterization."

"Post-COVID patients don't necessarily show symptoms, but pulmonary and cardiac abnormalities were observed in our study," she added. "Comprehensive multi-organ imaging may benefit convalesced patients by detecting sub-clinical findings, which may need careful follow-up."

Tracking the development of cardiac complications

The potential diversity of post-COVID complications is becoming apparent. The disease can provoke many conditions, such as myocardial dysfunction. Features of Canon Medical's ultrasound that can help differentiate the underlying evolution of complications are proving invaluable.

Dr. Yoko Kato,
MD PhD, Post-doctoral Fellow Cardiovascular Imaging, Johns Hopkins School of Medicine, Baltimore, US.

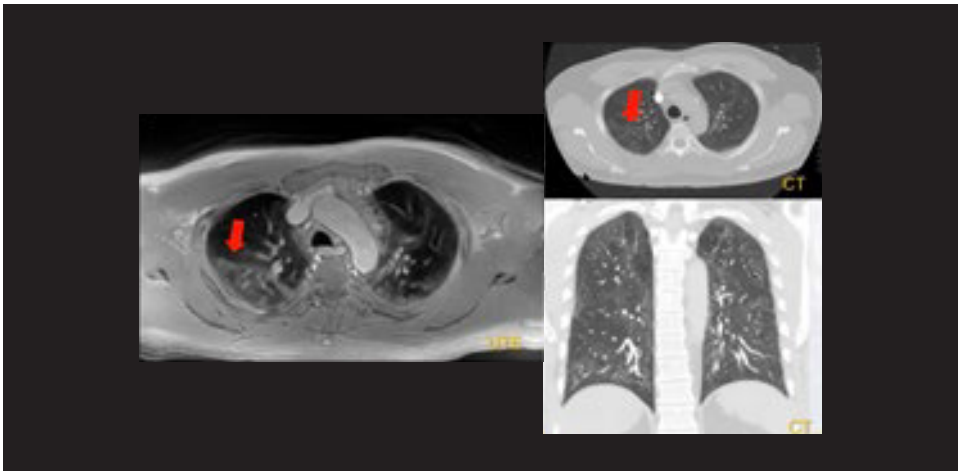


Figure 2. 58 year old male, presented with multifocal GGO on chest CT. In the corresponding slices of UTE (red arrows) high intensity areas are recognized, which have the same pattern as on CT.

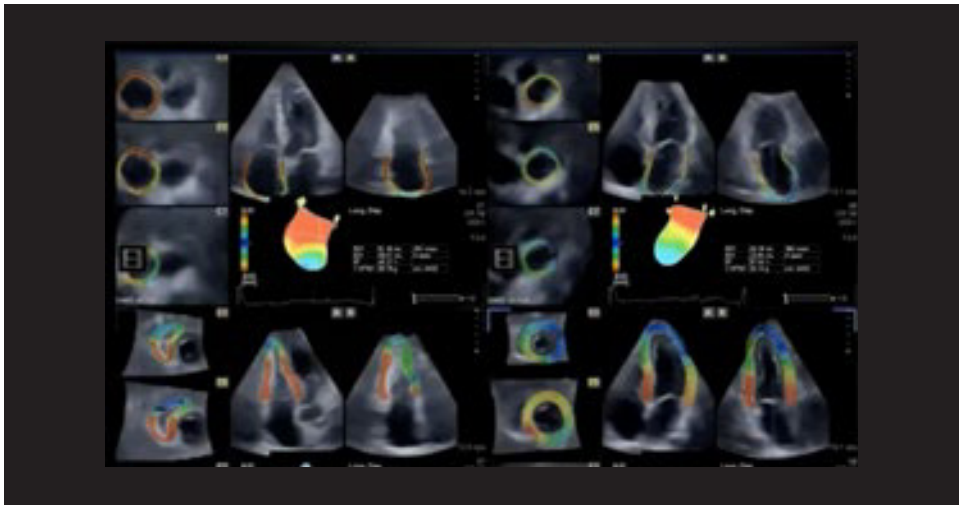


Figure 3. 3D Wall Motion Tracking with ultrasound for a complete analysis of all chambers of the heart.

Professor Leopoldo Pérez de Isla, MD, PhD, FESC, Cardiologist, Head of Cardiovascular Imaging Unit, Associate Professor, Clinico San Carlos, Complutense University of Madrid, Madrid, Spain.

"During the pandemic, we have learned that our Canon Medical's ultrasound system is very useful for two things: to 'rule out', and 'for early detection'," remarked Professor Leopoldo Pérez de Isla, Head of Cardiovascular Imaging Unit at Clinico San Carlos, Complutense University of Madrid, Madrid, Spain. "We can rule out the presence of cardiac failure, coronary endothelial dysfunction, pericardial involvement, dysautonomia or inappropriate tachycardia and the causes of chest pain. We can also detect several problems earlier such as myocardial dysfunction, pulmonary embolism and infective endocarditis."

"We know that COVID-19 is able to provoke several cardiac and pulmonary conditions by itself, but it is also able to decompensate a previous chronic heart failure. It is very useful to differentiate between heart failure and other problems because it has very important clinical implications, and we do it by means of echocardiography,' he added.

"My echocardiography system is also able to provide me with information that is crucial for the management of my patient," continued Professor Pérez. "It is able not only to show me the patients' left ventricle, for example, but also provides me with more information because we can use some technology, such as the auto ejection fraction, which means we can obtain the left ventricular ejection fraction (LVEF) in a very easy and a very fast way. With echo cardiography, we can study the contractility. We have even more accurate systems, such as wall-motion tracking." The Canon Medical system provides 2D Wall Motion Tracking and 3D Wall Motion Tracking.

"With this, we can analyze all four cardiac chambers for a complete analysis of the heart. The system is very accurate and can detect very early myocardial damage, for example," he said. "While experts might not immediately feel they need such a system, we have residents, fellows, and even non-cardiologists carrying out echocardiograms, and they are happy with an automatic system that is very easy to use and provides them with information from very accurate technology, regarding the contractility of the heart."

COVID-19 patients that have been admitted to hospital for a long period can suffer infections, and endocarditis must be ruled out.

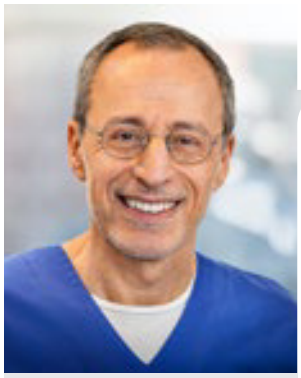
"In these cases, my system is also able to help me, because we can use the transesophageal probe in order to detect the presence of vegetations in the valves," remarked Professor Pérez. "We can use, not only the 2D image, but a color Doppler image and the 3D images. The accuracy of these images is really nice. We can use it in order to detect vegetations. Combining the 2D and 3D transesophageal images we can also analyze and obtain a lot of different measurements based on the tracking of the valves."

The ultrasound system is able to detect different thromboses at different locations.

"My ultrasound system is able to rule out diseases that are frequently seen in patients with COVID-19 as well as provide early detection of disease not seen with other imaging techniques. Early detection and rule out of disease is crucial for both diagnosis and management of patients with COVID-19," he concluded.

Advanced tools that lower dose in cardiac treatment procedures

The Bichat-Claude Bernhard Hospital, University of Paris, Paris, France, installed two Cath labs equipped with Canon Medical's Alphenix Core + systems. Professor Laurent Feldman, Professor of Cardiology and Director of the Catheterization Laboratory at the hospital has been particularly impressed with the dose reduction features of the new systems.



Professor Laurent Feldman, MD, PhD, Professor of Cardiology, Director of the Catheterization Laboratory, Bichat-Claude Bernhard Hospital, University of Paris, Paris, France.

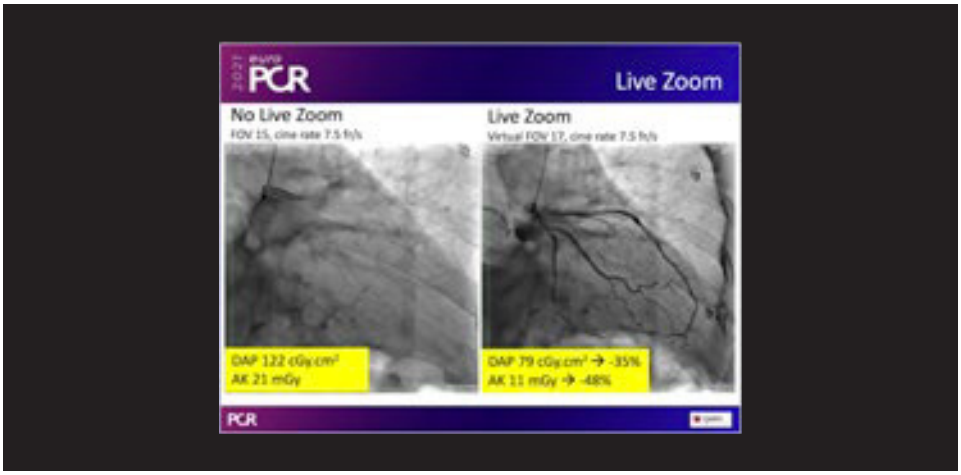


Figure 4. Via Live zoom the coronary images are magnified without increasing the dose, showing a dose reduction by 35 to 48%.

"We are using several of the tools routinely to reduce irradiation. The dose tracking system (DTS) is a very intuitive system, which provides the clinician with information on the skin dose delivered to the patient during the procedure.

Live zoom provides you a magnification of your views, but without increasing the dose. With Live Zoom, we have been able to reduce dose by 35 to 48%. It is a very interesting tool that provides a big image, good definition, at low dose."

SPOT ROI is another feature which is a very unique to the Canon Medical Alphenix Core + rooms that provides excellent definition of an area of interest, but with an attenuation of what is around this. This allows dose reduction of more than 60%.

"We are using this feature especially in a very complex PCI and CTO procedures, when we know that we're going to spend a lot of time, and that dose reduction is particularly important," he commented.

Stent Enhancer is another feature that Professor Feldman and his team use a lot.

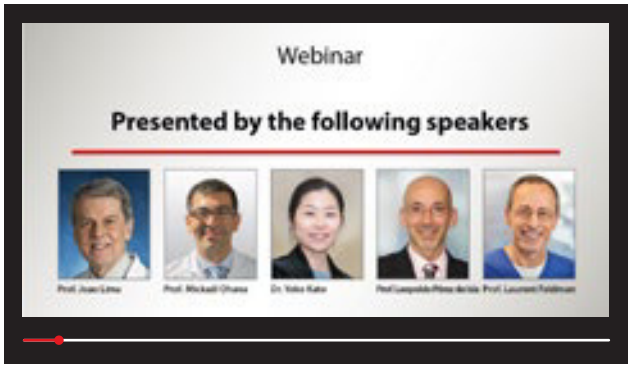
"It doesn't reduce dose necessarily but gives a very fine definition of the way a stent has been deployed. And by doing so, you don't have to do extra angiograms, and so altogether, you reduce the dose. The One-Shot function is only one frame, but if you do this properly you can have a very fine definition of the stent, you can see there is some underdeployment of the stent, and this clearly reduces the dose," he explained.

Another way to reduce the dose is to use less X-Ray and to carry out multi-modality imaging.

"We have integrated different imaging and physiology systems in our Alphenix Core + rooms," said Professor Feldman. "As they are integrated, they are very easy to use. Usually with one switch. So, more imaging, more physiology and less X-ray. That's a fine way to reduce dose."

Meeting challenges

While the challenges of the COVID-19 pandemic continue, research using Canon Medical's advanced technology is contributing to fighting the world's current health crisis. //



Scan the QR-code or click HERE to view the Post-COVID Conditions webinar

Precise IQ Engine (PIQE): A New Concept in Clarity and Confidence in Cardiac Imaging

Over the past year, Canon Medical has worked together with some of the world's top cardiac experts on the development of a Super-Resolution Deep Learning Reconstruction (SR-DLR) algorithm for use in cardiac CT. The resultant technology - Precise IQ Engine (PIQE) - delivers extraordinarily sharp cardiac images with significantly reduced noise and dose. Combined with whole-heart single-rotation coverage, it offers clinicians an entirely new level of clarity and diagnostic confidence in visualizing small vessels, plaques, and fine cardiac structures. VISIONS explores this exciting breakthrough through the eyes of some of those involved in PIQE's development.

Combined power

Canon Medical has created a new level of cardiac imaging with Precise IQ Engine (PIQE) by leveraging the power of the Aquilion ONE / PRISM Edition CT scanner's whole-heart, single- rotation cardiac coverage, and enhancing it with the Super Resolution benefits from the Aquilion Precision Ultra-High Resolution (UHR) CT scanner.

PIQE builds from the foundation of Advanced intelligent Clear-IQ Engine (AiCE), the industry's first Deep Learning Reconstruction algorithm for CT, and enhances cardiac image quality by using Deep Learning to bring the benefits of the Aquilion Precision Ultra-High Resolution CT scanner to the Aquilion ONE / PRISM Edition.

Powered by Altivity, PIQE takes deep intelligence to the next level for better cardiac imaging, with significantly reduced noise and dose, and improved contrast-to-noise ratio (CNR), all with no loss in low contrast detectability relative to conventional hybrid iterative reconstruction. The combination of improved spatial resolution, while maintaining low contrast detectability (LCD) helps improve visualization of stents and coronary plaque, both calcified and non-calcified, providing a more confident diagnosis of coronary artery disease.

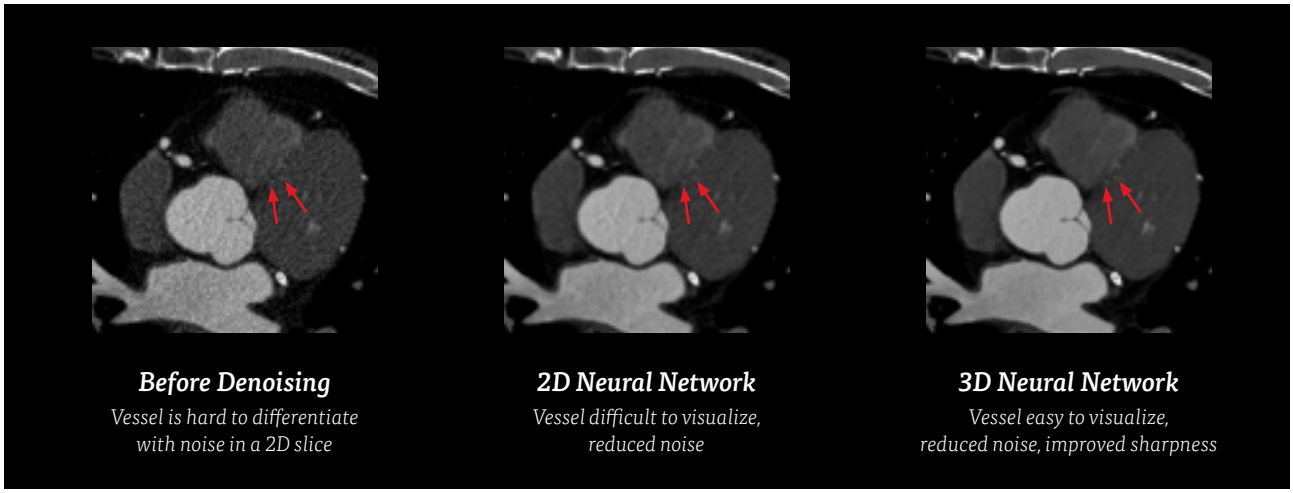
Three-dimensional

The PIQE Deep Learning Reconstruction algorithm is trained using data acquired on the Aquilion Precision CT system, which features UHR 0.25 mm to double high contrast signal definition. PIQE features a next generation, three-dimensional neural network that has been trained to identify and preserve signal features, both in-plane and longitudinally, throughout the heart. The algorithm is trained on high-quality cardiac cases that have been acquired on clinically operating, Aquilion Precision systems. PIQE's three-dimensional learning also helps ensure continuity in reconstruction of small, longitudinal vessels, which are often obscured by conventional reconstruction algorithms.

Extraordinary image quality

The National Institutes of Health (NIH) in Maryland, USA - the world's largest biomedical research facility - has been collaborating with Canon Medical for the last 12 years to improve CT technology and image quality. Dr. Marcus Chen, MD, Director of Cardiothoracic Imaging at the NIH worked closely with Canon Medical in the development of PIQE.

"With PIQE, it's as if you are wearing glasses for the first time," remarked Dr. Chen. "I can now see very fine detail. I can see small areas of calcification. I can see small stent struts."

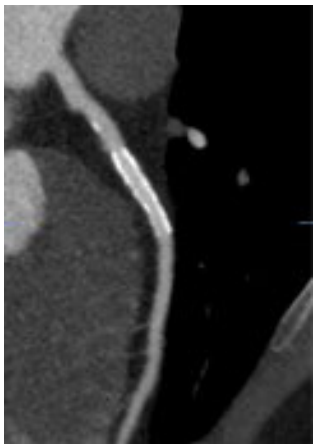


PIQE's three-dimensional learning helps ensure continuity in reconstruction of small, longitudinal vessels, often obscured by conventional reconstruction algorithms.

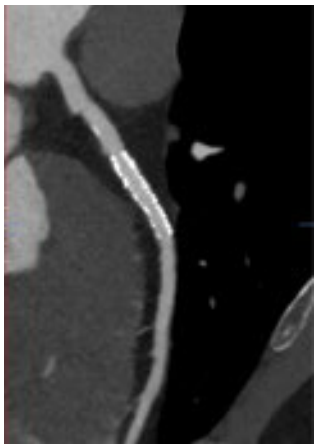
"What impresses me most about PIQE is its image quality. It has incredible sharpness and detail. And as I am able to see smaller structures more clearly, I know that I am making better diagnoses and delivering better healthcare for the patient."

Dr. Marcus Chen, MD, Director of Cardiothoracic Imaging at the NIH, USA.

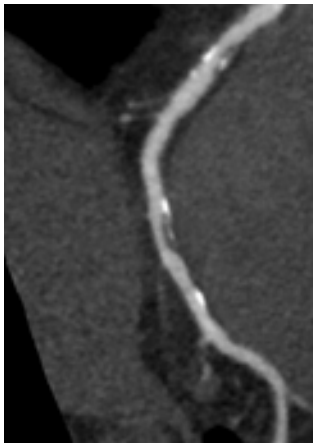
"What impresses me most about PIQE is its image quality. It has incredible sharpness and detail," added Dr. Chen. "With PIQE, we are now able to see individual stent struts, whereas, on the traditional imaging, they just look blurred.



LAD stent with AIDR 3D reconstruction



LAD stent with PIQE reconstruction



RCA plaques with AIDR 3D reconstruction

RCA plaques with PIQE reconstruction

With PIQE, we are now able to better visualize inside a stent and make a diagnosis whether or not a patient has in-stent stenosis. And the amount of blooming from calcified areas is minimized with PIQE reconstruction."

Integrated into workflow

The NIH considers the new tool to be so beneficial that it has integrated PIQE fully into the standard workflow for all cardiac examinations.

"It is completely integrated into our workflow," said Dr. Chen. "The speed of reconstruction by PIQE allows for a smooth diagnostic process. And as I am able to see smaller structures more clearly, I know that I am making better diagnoses and delivering better healthcare for the patient."

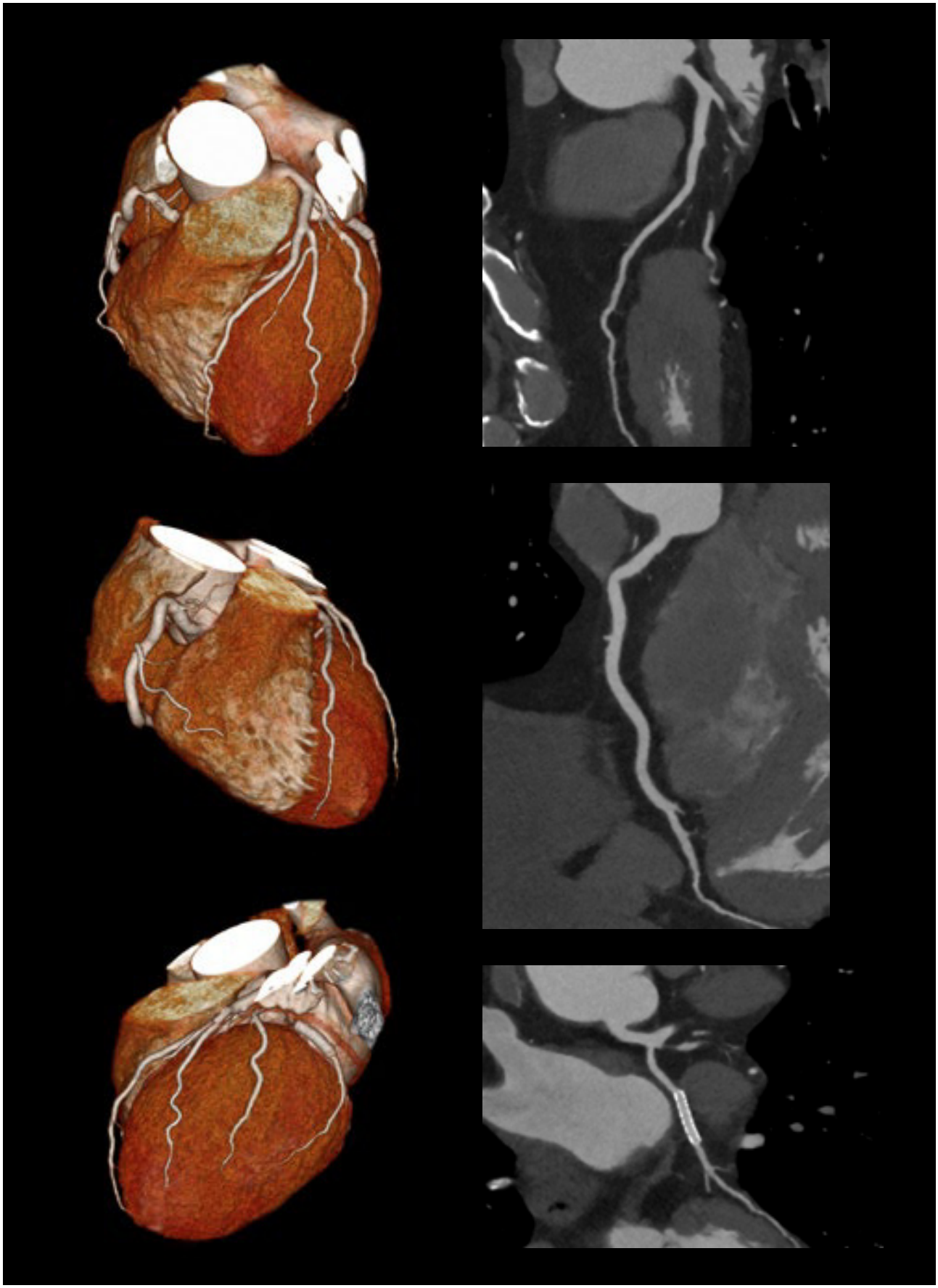
Ultra-High Resolution CT Systems from Canon Medical

Aquilion ONE / PRISM Edition

Canon Medical's Aquilion ONE / PRISM Edition offers One Beat Cardiac imaging: covering the whole heart in a single rotation via 320 detector rows of 0.5 mm thickness. The ability to image the heart in one 0.275 second rotation prevents misregistration and excludes artifacts caused by stitching or beat-to-beat variation.

Aquilion Precision

Canon Medical's Aquilion Precision CT system, introduced in 2017, was engineered from the ground up to create Ultra-High Resolution CT images. The system features 1792 detector elements per row, double the number of a conventional system, resulting in twice the intrinsic in-plane spatial resolution of a conventional CT detector. In addition, each of the 160 detector rows along the z-direction is 0.25 mm thick, half that of a standard CT detector.



Cardiac CTA with PIQE reconstruction showing a stent in the Circumflex artery.

"Stents placed in the coronary arteries of the heart can be visualized very clearly, and the calcium blooming artifact on the coronary arteries is also considerably reduced."

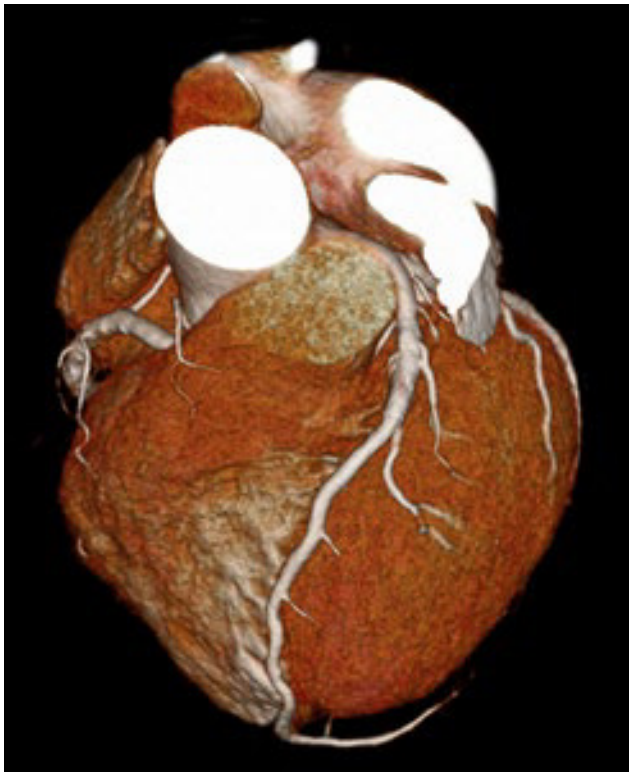
Dr. Kazuo Awai, Dean of the School of Medicine, Professor and Chairman Department of Diagnostic Radiology, at Hiroshima University, Japan.

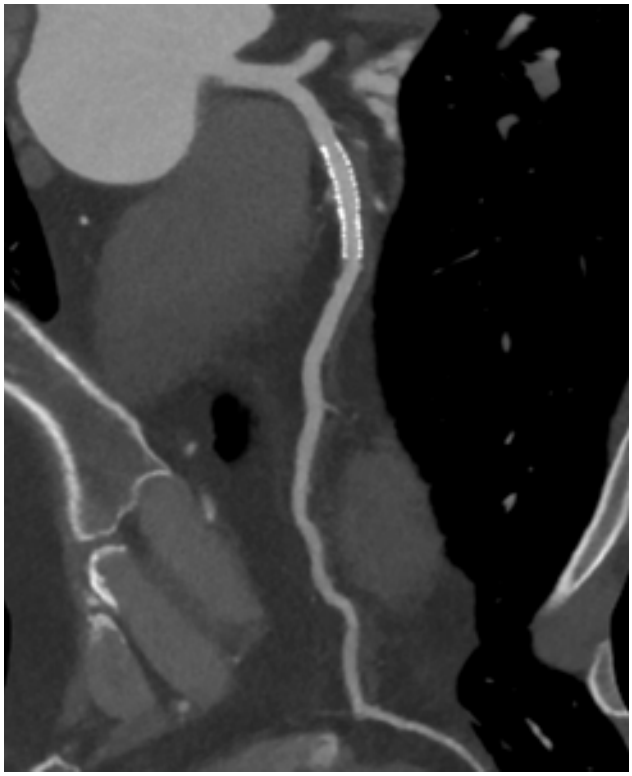
Natural texture

Dr. Kazuo Awai is Dean of the School of Medicine and Professor and Chairman Department of Diagnostic Radiology, at Hiroshima University, Japan. He has collaborated with Canon Medical Systems over many years on the development of many of its cutting-edge technologies, including Forward Projected Model-based Iterative Reconstruction SoluTion (FIRST), AiCE, Spectral, and now PIQE. Hiroshima University is a key collaboration site for the development of PIQE and has been the first field test site for the new technology.

"PIQE images use a high-resolution CT image as the target image for training, so it is a normal CT scan, but it is very unique in that it provides an image with very high resolution," he remarked. "For example, stents placed in the coronary arteries of the heart can be visualized very clearly, and the calcium blooming artifact on the coronary arteries is also considerably reduced. From this, I personally expect that the ability to depict fat in soft plaque will be improved in the future."

"What I have seen is that PIQE images have a very natural texture, and the noise appears to be greatly reduced. Noise, especially low-frequency noise, is strongly suppressed. Therefore, the image quality looks very natural," added Dr. Awai. "When low-frequency noise is improved, the ability to detect lesions improves. So, in that sense, I think this technology will increase diagnostic ability with CT. It has the potential to improve not only spatial resolution but also contrast resolution."





Cardiac CTA with PIQE reconstruction showing a stent in the proximal LAD.

"We see great potential for PIQE to improve the quality of cardiac imaging by reducing blooming artifacts from calcium and stents, improving visualization of small vessels, and reducing noise."

Dr. Yu, Director of CT R&D at Canon Medical Research, USA.

"In CT, the enemy of high resolution is noise," said Dr. Zhou Yu, Director of CT R&D at Canon Medical Research, USA. "To minimize patient dose, we often have to implement a denoising algorithm that will also sacrifice spatial resolution. As a result, we rarely get the maximum resolution that the system can provide. With deep learning reconstruction, we have redefined this resolution and noise trade-off. In PIQE, conventional denoising has been replaced with deep learning denoising, allowing the inherent resolution of the system to be expressed."

Creating a 3D neural network for PIQE has been key to its effectiveness.

"Most people in the field today use 2D neural networks. The challenge with 2D is that it is hard to differentiate small features, like small vessels, from noise in 2D. With a 3D neural network, the network has additional information from adjacent slices to differentiate these small features versus noise," explained Dr. Yu.

With all of the technical ingredients put together, it is also important to incorporate clinical knowledge into our development.

"In the end, it is the clinician who reads the image and makes the diagnosis," said Dr. Yu. "To do that, we work closely with clinicians to understand the clinical use case, the image quality preference, and to fine-tune our training target and training method to maximize the image quality."

Great potential

The development team are excited about PIQE technology and look forward to seeing it being used in the field.

"We see great potential for PIQE to improve the quality of cardiac imaging by reducing blooming artifacts from calcium and stents, improving visualization of small vessels, and reducing noise," added Dr. Yu. //

Scan the QR-code or click HERE to watch the video

Left: Dr. Jean-Christophe Sananes
Right: Pr. Vincent Dousset

VISIONS spoke with Dr. Jean-Christophe Sananes, President of GIE R2 Gironde and Pr. Vincent Dousset, Director of IBIO

French Radiologists Join Forces to Reduce MRI Scan Time with the Vantage Galan 3T

An original alliance using Canon MRI scanners in France has given birth to a new set of sequences to explore the human brain with 3T MRI in just six minutes. This unique collaboration between researchers and clinicians may help tackle MRI access issues in daily practice and could be extended to other clinical applications to improve patient care, two renowned experts told VISIONS.

A pioneering cooperation in France

When the finest clinicians and researchers work together with the same breathtaking equipment, great things can happen.

GIE R2 Gironde, a company that utilizes the expertise of more than 180 radiologists, and IBIO, a prestigious research institute in the Bordeaux region, have known each other for a long time. They have also both recently installed the Vantage Galan 3T MRI scanner. When IBIO researchers started to develop new sequences with the equipment, they opened a new path for the two entities to cooperate more closely, according to GIE R2 Gironde President Dr. Jean-Christophe Sananes.

"In daily clinical routine, we need fast sequences that use AI and denoising techniques," he said. "We were very interested in those sequences that IBIO had been working on."

In late 2020, the organizations decided to join forces to apply the sequences

"One of the main questions is how to develop sequences that can be translated into clinical daily practice. That's why we chose to collaborate with GIE R2 Gironde, whom we've known for a long time, to test the sequences."

Prof. Vincent Dousset, Director of IBIO,
Research institute in the Bordeaux region, France.

developed by IBIO in clinical practice, to help expedite diagnosis and follow-up of patients with MRI. Through the Bordeaux University Foundation, a PhD candidate was hired to help implement this work in daily practice in order to bring optimal benefit to patients.

Canon's Vantage Galan 3T scanner combines some of the most powerful gradients in the world with game changing image improvement techniques such as the Advanced intelligent Clear-IQ Engine (AiCE) software, an AI-based solution that identifies and removes noise from images. With this cutting-edge equipment, IBIO managed to create incredibly fast sequences to boost MRI and spread its use in clinical practice. But these kinds of advances need help to make it into the daily routine setting, IBIO Director Prof. Vincent Dousset explained.

GIE R2 Gironde, Bordeaux, France.

Canon's Vantage Galan at the GIE R2 Gironde.

"One of the main questions that researchers are confronted with is how to develop sequences that can be translated into clinical daily practice," he said. "That's why we chose to collaborate with GIE R2 Gironde, whom we've known for a long time and totally trust, to test the sequences."

Bringing research and clinical practice under one roof is somehow atypical in France, but the approach is starting to pay off. GIE R2 Gironde and IBIO are about to present results that could help shorten and harmonize MRI examinations of patients with brain disease.

"We've developed a large set of very short sequences with high resolution that can be applied to screening most brain diseases as a routine protocol. It's called the Welcome Pack and it enables to expedite and standardize MRI examinations of the whole brain," Prof. Dousset said.

The Welcome Pack[1]: a new tool to help radiologists using MRI

Working in a timely fashion is the radiologist's dilemma when scanning with MRI. "We need to standardize MRI examinations and perform them in a short time, as we do with CT," he said. "We thought of which basic sequences would be necessary to perform MRI exploration of the brain as easily as CT, in order not to miss anything and go fast."

With Canon's help, Prof. Dousset and his team condensed six basic sequences - a T1, T2, FLAIR, TOF, T2* and diffusion - into the same rapid MRI examination to scan all of the brain pathologies.
The goal was to reduce scan time and the team worked on refining every possible sequence technique. "We also drew on other techniques, such as the Fourier transform, and everything we had at hand to optimize sequences. We also applied the AiCE innovative solution available on the Vantage Galan 3T to remove noise from the images."

The outcome is a significant gain in time, offering the ability to scan patients in just five minutes in 2D[1] and six minutes in 3D[2]. Because all the basic sequences have been included in the combination, patients do not have to be scanned again in the case someone else reads the study later.

"The effect is doubled. We can examine patients very rapidly and if there's an additional reading, there's no need to recall patients," Prof. Dousset said.

The experience in daily practice has impressed Dr. Sananes. "We've been using the Welcome Pack on our Vantage Galan 3T for three months and we're extremely surprised and happy to obtain all the information about the brain in just six minutes," he said.

Dr. Sananes at the GIE R2 Gironde.

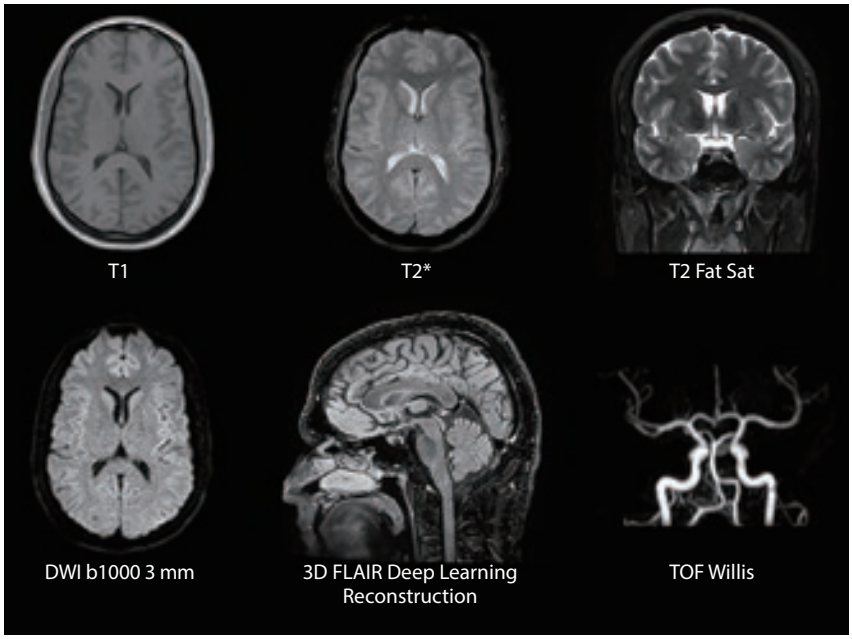


Figure 1: 6 sequences including 3D FLAIR and TOF
*Ax T1W : 20 sec, Ax T2*W : 36 sec, Co T2W FatSat : 33 sec*
Ax DWI/b1000 : 28 sec, 3D FLAIR : 100 sec, 3D TOF : 59 sec

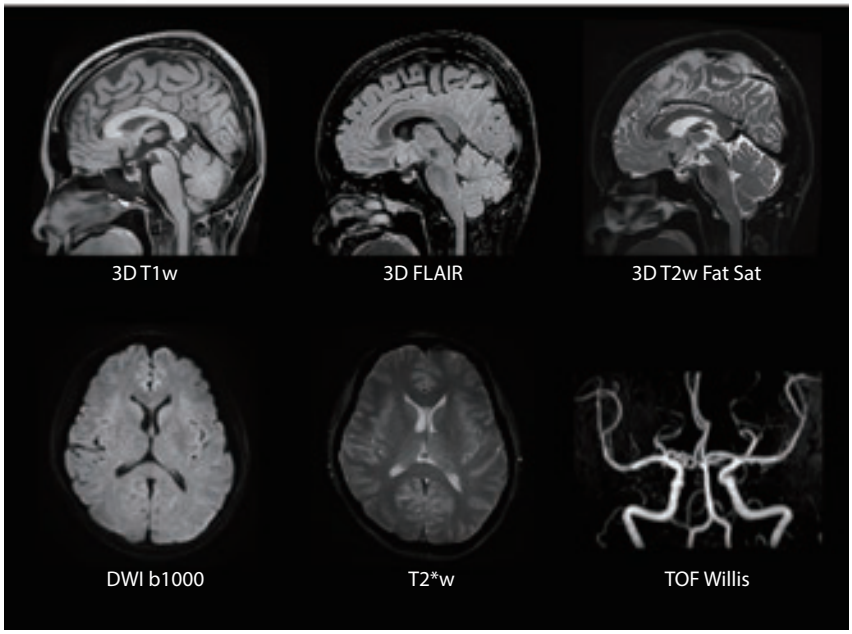


Figure 2: Typical 3D Welcome Pack Images on one volunteer. Total scan time: 6 min 21 sec.
3D T1W: 66 sec, 3D FLAIR: 100 sec, 3D T2W FatSat: 73 sec,
*Ax DWI/b1000: 88 sec, Ax T2*W: 96 sec, 3D TOF: 119 sec*

"We've run tests and use it more and more often. The machine offers very high quality and optimized images. The Welcome Pack brings us a very interesting rapidity without degrading image quality."

Such fast sequences may well enable to design and implement new workflows that shorten MRI waiting times and improve MRI access for both clinicians and patients, Dr. Sananes suggested.

"The solution is very innovative and answers a very strong demand from clinicians who are refrained in their diagnosis by waiting times or the difficulty of obtaining MRI exams. Thanks to those fast sequences, we could unleash MRI's potential to answer clinicians' needs and improve care, notably for semi-urgent patients," he said.

For Prof. Dousset, being able to test his team's research in the clinical setting may pave the way for other interesting projects using fast acquisition and image denoising techniques. "Hopefully we can prove the efficiency of such techniques over already established ones with this project, and look forward to more initiatives in the future," he said.

Potential future applications

Besides brain imaging, a number of applications could benefit from IBIO's fast sequences, including neck and MSK pathologies.

Dr. Sananes would also like to take the Welcome Pack down to the pelvis and the abdomen. "This is a delicate region to image with 3T because of artifacts that are triggered by movement. AI's role is to get rid of those artifacts. Prostate MRI is all set to take off with AI-boosted MRI," he said.

Research is all about pushing the frontiers. MRI already enables the ability to do functional imaging, but advances must be made to improve image quality, Prof. Dousset said. "The prostate, spinal cord and other organs and regions remain complicated to access. There's also a lot of work to be done to image the pituitary gland and vessel wall pathologies, which are quite frequent. Image quality needs to be improved to properly visualize atherosclerosis or aneurysm risk."

With Canon Medical Systems' unmatched support, radiologists have a strong ally to accompany their endeavors.

"The solution is very innovative and answers a very strong demand from clinicians. Thanks to those fast sequences, we could unleash MRI's potential to answer clinicians' needs and improve care, notably for semi-urgent patients."

Dr. Jean-Christophe Sananes, GIE R2 Gironde President

"Our cooperation with Canon Medical Systems scientists has been extremely positive in our collaboration with IBIO. It's rare and brings real advances," Dr. Sananes said.

"We've received excellent technical support from Canon. We have a shared vision of research that enables us to go further and push this idea that transcends the usual French public-private scheme, to develop techniques that improve patient care," Prof. Dousset concluded. //

References

[1] *Welcome Pack: a standardized brain MR examination with six sequences in less than 5 minutes. Vincent Dousset, M.D., Ph.D. (PU-PH) Director of IBIO University of Bordeaux and University Hospital of Bordeaux; https://global.medical.canon/products/magnetic-resonance/aice-customer-experience*

[2] *3D Welcome Pack with Advanced intelligent Clear-IQ Engine (AiCE): a standardized 3D brain MR examination with 6 sequences in 6minutes. Vincent Dousset, M.D., Ph.D. (PU-PH) Director of IBIO University of Bordeaux and University Hospital of Bordeaux; https://global.medical.canon/products/magnetic-resonance/aice-customer-experience*

Patrice Coudray (Canon Medical), Bruno Triare (Canon Medical), Dr. Sananes, Professor Dousset.

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Professor Mathias Prokop MD, PhD, Chairman of the Department of Radiology & Nuclear Medicine, Radboud University Medical Center, Nijmegen, the Netherlands

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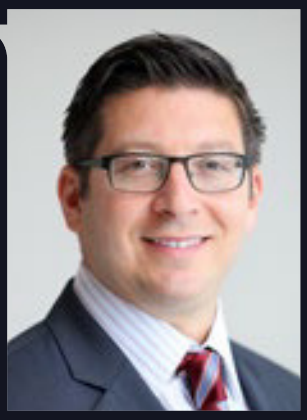
Dr. Kenneth Snyder, MD, PhD, FACS, FAANS, Associate Professor of Neurosurgery SUNY, Gates Vascular Institute, Buffalo, New York



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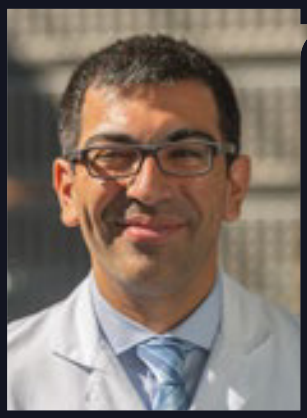

"DLR helps to deliver homogeneous iodine maps with sharp margins that can be achieved at low keV and also at high keV. Which means that you can achieve relatively good image quality over a wide range of monochromatic levels and material specific images."

Mickaël Ohana, MD, PhD, Strasbourg University, France

Ultrasound solutions

Through leveraging the power of AI, Canon Medical has been able to automate standardized measurements to increase clinical productivity and reporting accuracy.*

"The new Aplio i-series from Canon helps me a lot, because we can get information from very difficult patients in no time. How? It is possible with automatic measurements due to Artificial Intelligence. That's the keyword and the future too."

Prof. Michel Zuber, Cardiologist, Cantonal Hospital Aarau, Switzerland

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At the Forefront of Elite MSK Ultrasound with the Aplio i800 / Prism Edition

Aaron Fleming is a Senior Sonographer at Qscan Radiology's Red Hill Clinic in Brisbane, Australia – a leading diagnostic medical imaging and interventional practice that provides the imaging for numerous professional sporting teams and organizations as well as the general public. Aaron has a particular interest in MSK ultrasound that has evolved from an unparalleled passion for sport – a product of his upbringing in country NSW. One of the first specialists to scan with the new Aplio i-series / Prism Edition ultrasound system from Canon Medical, Aaron explained to VISIONS how the advanced new features and improved ergonomics enhance the scanning experience and facilitate greater accuracy in ultrasound diagnoses.

Striking additions

Aaron presented on his initial experiences of the Aplio i-series / Prism Edition at its global launch at the 2021 Australasian Sonographers Association (ASA) Conference in Brisbane, Australia, as well as at the Singapore Radiological Society and College of Radiologists.

"Scanning with the Aplio i800 / Prism Edition was a fantastic experience," he remarked. "First and foremost, the image quality is the main strength. It allows

improved visualization of anatomy and pathology and, therefore, improved diagnostic accuracy.

Some of the cases scanned and images obtained during my experience with the machine are testament to the quality of the system."

In addition, there are a number of really smart new features that improve the overall scanning experience. Some highly advanced new technologies, the customizable control panel and interface, the electric lift button and the increased versatility of the transducers were all striking additions to the new Aplio i-series / Prism Edition.

iBeam+ technology on the new Aplio i-series / Prism Edition emits, receives and processes ultrasound with up to four times faster image processing. The improved bandwidth and processing power of the iBeam+ beamformer results in images with better penetration and detail resolution, so more can be seen without having to switch to a lower frequency transducer.

Aplio's innovative Full Focus function enables clear, uniform images from near to far field without the need for tedious focus adjustments. With fewer application steps and greater uniformity, this can be particularly useful for a number of examinations.

Next-generation Superb Microvascular Imaging (SMI) capability on the Prism Edition is further enhanced to provide a higher frame rate, leading to better visualization and less clutter. Doppler luminance also produces an aesthetically pleasing image.

Advantages of the Prism Edition for MSK

'From an MSK point of view, I think this system can help challenge and even overturn the notion that MRI is the gold standard for MSK imaging,' Aaron says. Ultrasound offers many benefits over MRI such as availability, cost and superior spatial resolution to name but a few. Tendon and especially nerve assessment with ultrasound can trump MRI. Furthermore, ultrasound can be used for screening checks and in the rehab and progress of various injuries providing invaluable prognostic information and up-to-date return to play estimates for the team that oversees the care and treatment of professional and amateur athletes.

"There are a number of new, really smart features that improve image quality as well as the scanning experience."

Versatile transducers

"The Prism Edition's transducers are very versatile. The matrix probes all produced fantastic images and you could have quite easily performed the same scan with a number of different probes with no loss in scanning confidence."

For Clinical Case 1 – Aaron used a High Frequency 24 MHz (i24LX8) linear matrix transducer, to demonstrate an intact Flexor Digitorum Profundus (FDP) and Flexor Digitorum Superficialis (FDS) tendons of the second finger. However, there were changes to the echogenicity of the adjacent lumbrical muscle. The muscle appeared enlarged and heterogenous with anechoic areas consistent with fluid. Increased vascularity was detected with SMI using Doppler luminance. These findings are consistent with a partial tear of the first lumbrical muscle of the hand – an unusual occurrence.

Scan the QR-code or click here to view the presentation

Qscan

Qscan Radiology Clinics is a comprehensive Diagnostic Medical Imaging & Interventional practice with subspecialty trained Radiologists, and highly trained clinical and support staff across multiple clinics in South-East Queensland and additional Qscan Group partner clinics elsewhere in Australia.

Qscan Radiology has a team of Radiologists who are highly experienced in sport imaging.
https://www.qscan.com.au

In another case, Clinical Case 3, the Aplio i800 / Prism Edition's 22 MHz High Frequency Hockey Stick transducer (i22LH8) was used to scan the thumb of an elite AFLW player – whose thumb was injured in a contest. A full thick- ness tear of the RCL and an avulsion fracture of the first metacarpal joint were visualized. Ultrasound findings also suggested a partial thickness tear of the UCL with no Stener lesion.

Canon Medical provides two high-frequency hockey sticks from 17 to 22 MHz with the Aplio i800 / Prism Edition. Both hockey sticks have a very fine footprint that allows easy access for imaging superficial areas in hard-to-reach anatomical places. 'The interventional radiologists were also big fans of the hockey stick transducers.'

Better ergonomics

Ergonomics are an important aspect of scanning for any sonographer.

Aaron found that the electric lift button as a sit/stand sonographer improved this aspect tremendously.

"New, highly advanced technologies, the customizable control panel and interface, the electric lift button are all striking features to the versatility of the Aplio i-series / Prism Edition."

Biography

Aaron Fleming is a Senior Sonographer at Qscan Radiology Red Hill Clinic, in Queensland, Australia – a leading diagnostic medical imaging and interventional practice with a high level of expertise in sport imaging. Aaron has a particular interest in MSK that has evolved from his passion for sport.

He graduated from radiography at Newcastle University in 2009 and completed a post-graduate diploma in Medical Ultrasound at Queensland University of Technology (QUT), Brisbane, Australia, in 2013.

He also found the Aplio i800 / Prism Edition was very customizable which added benefits not just to ergonomics but in flattening the learning curve inherent in adjusting to a new machine.

"Similar to previous models, you have control over the setup of the control panel and interface. Therefore, there is next to no lag time in adjusting to a new machine," he said. "Furthermore, the additions to previous models are all very intuitive, so it was very easy-to- use, and the learning curve was very smooth."

Vast possibilities

With some prior knowledge of the Aplio i-series, Aaron was not really surprised by the image quality of the latest Aplio i800 / Prism Edition, however he was impressed with the further improvements to the already strong features of previous Aplio systems.

"It's exciting to think of where this could lead," he said. "The potential possibilities are vast and really positive for ultrasound. Some of the AI components of the new Aplio system are a really exciting prospect. I didn't get to use a lot of these in this instance, but AI is something that I think sonographers and radiology should really embrace." //

Scan the QR code or click HERE to watch Canon Medical's video about the Aplio i-series / Prism Edition!

Clinical Cases

Case 1: Lumbrical Tear

This case features a 49-year-old female patient who sustained an injury at yoga, and was referred for an ultrasound of her right hand. The patient presented with a small lump on the palmar aspect of her right hand, over the second metacarpal. She also had pain associated with flexion and extension of the index finger. Differential diagnosis at the time of referral was Dupuytren's contracture, a collagen disorder where the fascia in the hands becomes thickened and fibrotic. The abnormal collogen proliferation of this disorder means the condition will often first present as a thickening or nodule in the palm.

The Flexor Digitorum Profundus (FDP) and Flexor Digitorum Superficialis (FDS) tendons of the second finger were seen intact however there were changes to echogenicity of the adjacent lumbrical muscle. The muscle appeared enlarged and heterogenous with anechoic areas consistent with fluid. Increased vascularity was seen with Superb Microvascular Imaging (SMI) using Doppler luminance. These findings are consistent with a partial tear of the first lumbrical muscle of the hand.

An interesting case study of an uncommonly seen lumbrical injury.

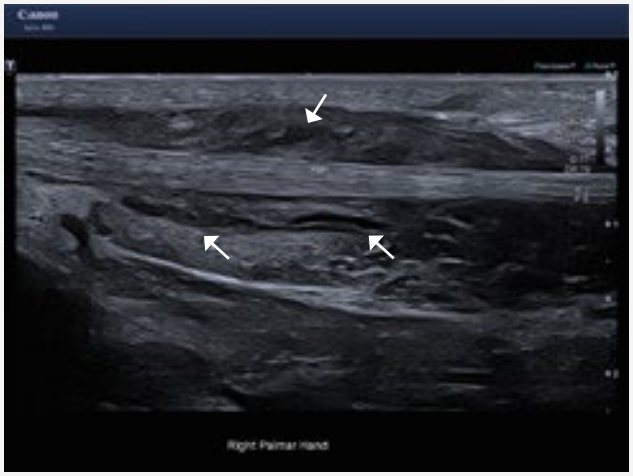


Figure 1: The FDP tendon in the longitudinal plane. Changes in echogenicity of the adjacent muscle are clearly demonstrated.

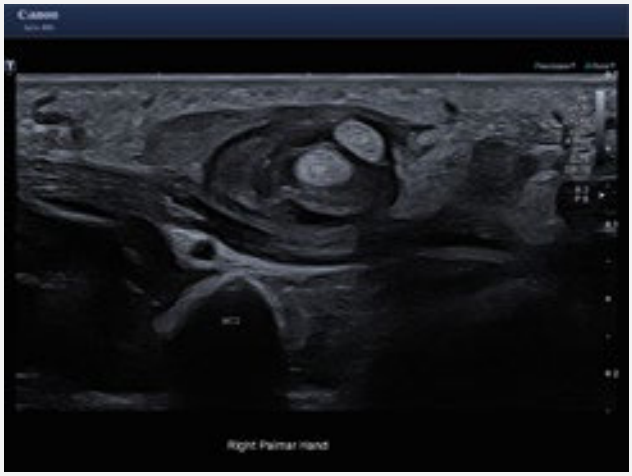


Figure 2: Transverse imaging of the same area shows the FDP and FDS in cross section with surrounding changes of the lumbrical muscle.

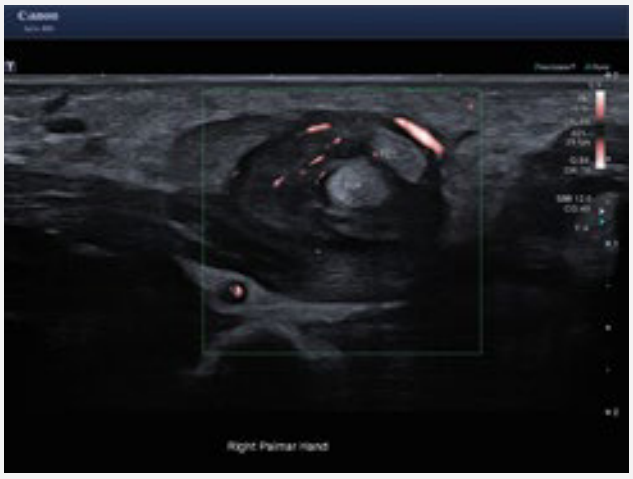


Figure 3: Increased vascularity was demonstrated. SMI helps to detect and demonstrate the detail of the fine vessels in the area of interest.

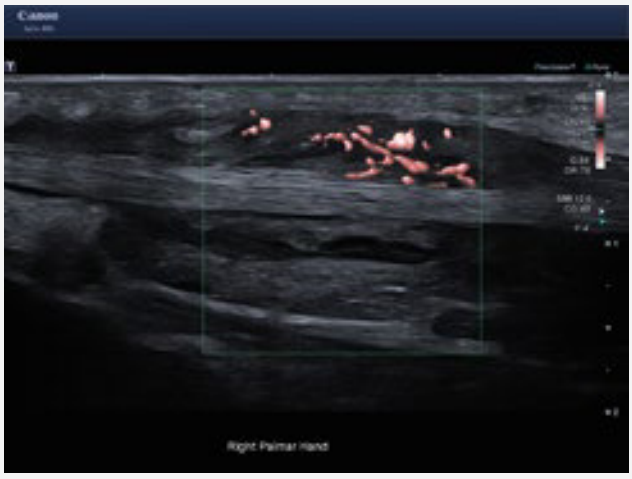


Figure 4: Longitudinal imaging with SMI shows marked hypervascularity to the injured region.

** Ultrasound examination was performed using a High Frequency 24 MHz (i24LX8) intelligent Dynamic MicroSlice (iDMS) transducer.*

Case 2: Distal Biceps Tear

This case study follows a 52-year-old firefighter who presented to his doctor with pain in his left elbow upon pronation and supination. There was no acute injury reported by the patient. Possible distal biceps tendinosis was thought to be the cause of his symptoms.

The scan revealed a high-grade partial tear of the distal biceps at its insertion, predominantly involving the long head of biceps. Some vascularity in the distal biceps was also demonstrated with Superb Microvascular Imaging (SMI). Post diagnosis, it was recommended that the patient return for a Platelet Rich Plasma (PRP) injection into the area to help with tendon repair and alleviate symptoms.

Partial tear findings of the long head of biceps are an important diagnosis to help prevent the possibility of further full thickness tearing. The deep section of the distal insertion of biceps can be difficult to image.

** Ultrasound examination was performed using the versatile 18 to 5 MHz (i18LX5) intelligent Dynamic MicroSlice (iDMS) transducer able to cover all joints and MSK structures from skin to bone.*

Figure 1: The biceps can be seen at its distal insertion onto the radial tuberosity. The deep portion of the tendon is seen to be heterogenous over an area of 21mm thought to be consistent with a partial tear of this tendon.

Figure 2: SMI shows some increased hyperaemia in the region of interest.

Case 3: Radial Collateral Ligament Tear

A 29-year-old female AFL player presented with pain in the first metacarpophalangeal joint (MCP) following a hyper-extension injury.

A full thickness tear of the radial collateral ligament (RCL) and an avulsion fracture of the first metacarpal joint were visualised. Ultrasound findings also suggested a partial thickness tear of the ulnar collateral ligament (UCL) without a Stener Lesion.

The ulnar and radial collateral ligaments are the two main supporting structures that traverse the metacarpo-phalangeal (MCP) joint of the thumb. Forced adduction is the most common cause of injury to the RCL, while forced abduction movements are the cause of most acute injuries to the UCL. The damage sustained to both ligaments were clearly demonstrated in this hyperflexion case.

** An ultrasound examination was performed using a 22 MHz High Frequency Hockey Stick transducer (i22LH8) with very fine footprint allowing easy access for imaging superficial areas in hard-to-reach anatomical places.*

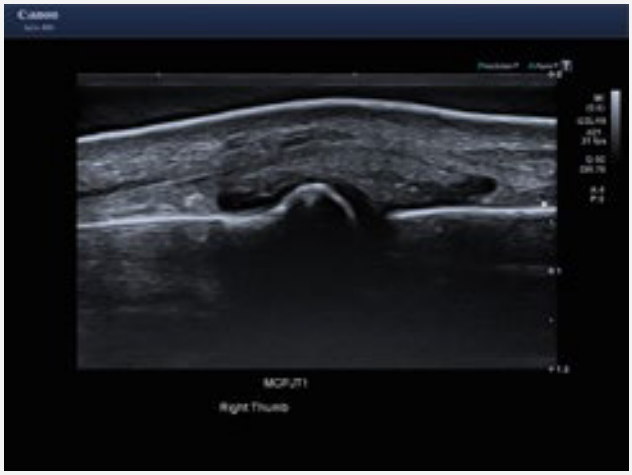


Figure 1: Imaging of the MCP Joint clearly demonstrates fluid emanating from the joint.

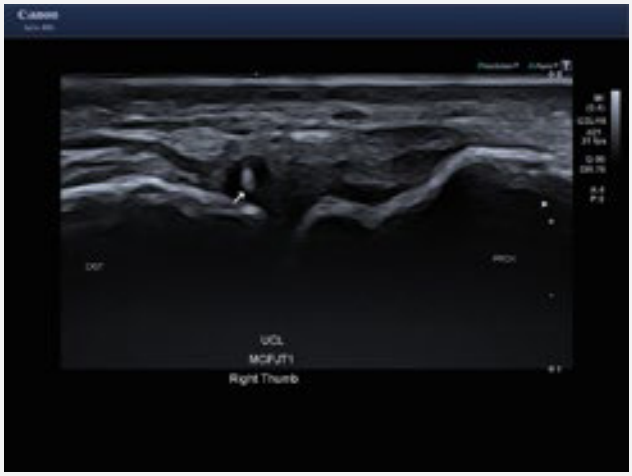


Figure 2: Imaging of the UCL shows and echogenic area at the distal portion of the ligament. Findings are suggestive of a partial tear.

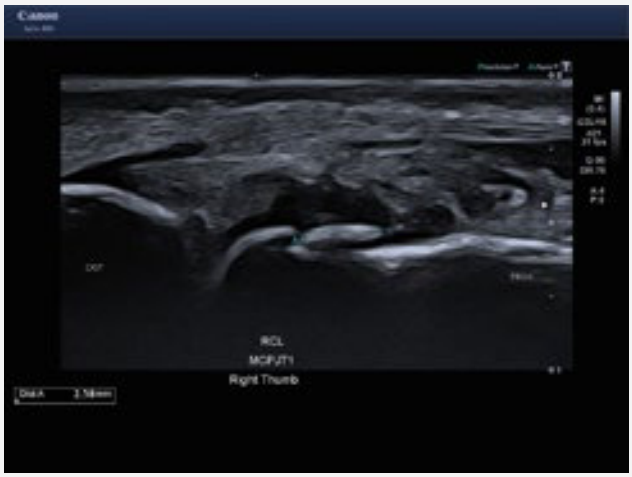


Figure 3: Imaging of the RCL of the thumb shows a 2.5mm echogenic area at the proximal portion of the ligament suggestive of an avulsion fracture.

Lynne Thomson, CT/MRI Superintendent, The Royal Infirmary of Edinburgh (Scotland), part of NHS Lothian.

Royal Infirmary of Edinburgh Impressed with CT Image Quality at High Speed and Low Dose

AI Powered CT Scanners increase the breadth of clinical procedures.

The Royal Infirmary of Edinburgh, a major acute teaching hospital in Scotland and part of NHS Lothian, has recently installed two new AI-assisted CT scanners from Canon Medical. Designed using Deep Learning Reconstruction, the systems are powered by an Advanced intelligent Clear-IQ Engine (AiCE) to deliver high quality medical imaging at speed to overcome the time vs patient demand challenge that most hospitals face today.

A range of software applications also expands the procedures and possibilities for clinical practice and research.

In CT Pulmonary Angiography, iodine mapping is used as standard which provides the radiologists with extra information to aid diagnosis. A greater level of information delivered more quickly is better for clinical decision-making and is now achieved at lower dose. Similarly, Interventional Radiologists have found the subtraction package for CT Peripheral Angiograms extremely valuable. This provides excellent visualisation of the vessels, replacing the need to see vascular calcification via an MRI scan, which is not suitable for many patients, but still with reassurance of the dose being low. All of the processing is done automatically by the CT.

The Royal Infirmary of Edinburgh (Scotland), part of NHS Lothian, has recently installed two new AI-assisted CT scanners from Canon Medical. Pictured L to R: Iain Gray, Account Manager at Canon Medical; Lorna Chalmers, Radiographer; Lynne Thomson, CT/MRI Superintendent; Matthew Reilly, Radiographer; and Colin Fraser, Clinical Assistant.

Furthermore, using the CT fluoroscopy package, the time taken to undertake biopsies has halved, therefore reducing examination times for patients undergoing uncomfortable procedures.

"As radiographers we can become blasé about the imaging equipment we use on a daily basis, but the arrival of the new Aquilion ONE / PRISM Edition and Aquilion Prime SP CT have reminded us of the amazing innovation going into medical imaging today. Our cardiologists have been blown away with how quick a cardiac CT is acquired using the wide detector, as well as the image quality achieved at such low doses." states Lynne Thomson, CT/MRI Superintendent at the Royal Infirmary of Edinburgh.

She continues, "It's not just the speed, low dose and image quality that have impressed us, but also the versatility of the new CT scanners. The 'Area Finder' functionality is useful for 4D joints and extremity imaging, which means we can seat patients at the end of the scanner. We have plans to adapt the way we book appointments for inpatients and outpatients since the arrival of the new CTs, which will lead to better workflow across a number of departments at the hospital."

Mark Thomas, CT Modality Manager at Canon Medical Systems UK states, "There is no trade off in welcoming AI into the imaging department today through CT. No apprehension or anxiety should be part of the decision about embracing the future of AI in medical imaging. Our scanners are built to be used in the same way that radiographers are used to but have intelligent technology inside powering the processing and steering the quality of image output. This illuminates enthusiasm and initiates a brighter future of CT scanning."

"We have had trust in Canon Medical Systems for nearly two decades with a long-standing positive relationship in its medical imaging innovation, and for its after-sales and customer service.

> *"Our cardiologists have been blown away with how quick a cardiac CT is acquired using the wide detector, as well as the image quality achieved at such low doses."*
>
> *Lynne Thomson, CT/MRI Superintendent*

When our current 10-year-old CT scanners reached end of life, Canon Medical was again the natural choice. The new generation of Aquilion CT scanners is outstanding compared to what we were used to. Our radiologists have been amazed by the improved image quality and speed of procedures, and as radiographers, we are very pleased at the significantly reduced dose to patients," Lynne Thomson concludes. //

Eye Care – A Window to the Heart

Microvascular changes that occur with different heart conditions can often be detected in the eye with advanced imaging techniques. Several cardiology experts are exploring the possibility of assessing certain cardiovascular diseases through eye examination with optical coherence tomography angiography (OCTA) - a relatively new imaging tool that can map blood flow in the eye in detail. Professor Patrick De Boever, working at the University of Antwerp and Hasselt University, in Belgium, is one of the experts pioneering minimally invasive, time and resource saving OCTA for cardiological investigations.

Instead of diagnosing heart conditions through complex techniques, the eye can provide a convenient and accurate source of information about the cardiovascular system and the microvasculature of the heart.

"Looking at the eye can be very interesting, because it's very easy and it can really tell you something about the microcirculation," said Prof. De Boever. "This is possible because the eye is optically transparent, and so, with very easy imaging techniques, we can look at the back of the eye or the retina. The retina reveals a great deal of relevant information."

Sophisticated new technology

There are different techniques for imaging the retinal microvasculature, including the classical digital camera to collect a 2D image. The blood vessels can also be explored using optimal coherence tomography (OCT). The newer variant: optical coherence tomography angiography (OCTA) can detect the movement of red blood cells in the retinal blood vessels and the technology allows visualization of the tiniest vessels in detail.

"OCTA allows you to go to microlevel analysis of the microcirculation to examine changes in retinal vessel parameters and metrics and it is a promising, non-invasive technique for vascular assessments," remarked Prof. De Boever.

Digital retinal images can be processed to calculate metrics such as the dimensions of vessels, including arterial widths, venule widths, and the ratios between vessels. Information linked to the geometric patterns can also be extracted, such as how many times these vessels branch, the complexity of the branches, the straightness of the vessels, the curviness of the vessels. An impression of the complexity of the vessel pattern can be obtained using impression of the complex vessel pattern can be obtained using fractal dimensions.

"These types of measurements have been used already for a long time to associate retinal microvascular changes with different cardiovascular outcomes," said Prof. De Boever.

Proven indicator of cardiovascular risk

In particular, changes in the values of the widths of retinal vessels have been shown to be a good (predictive) indicator for the development of hypertension.

"The Xephilio OCT-A1 allows you to go to microlevel analysis of the microcirculation to examine changes in retinal vessel parameters and metrics."

Professor Patrick De Boever, Research & Innovation Manager at the University of Antwerp and Hasselt University, Belgium.

Patrick De Boever is research and innovation manager at the University of Antwerp. He has a part-time appointment as a professor at Hasselt University. Previously, he was the team leader of the MONA group (Flemish Institute for Technology, VITO), focusing on retinal image analysis using artificial intelligence for diagnostic screening and epidemiology research. The team's work resulted in August 2021 in launching the digital health startup company MONA with the first product on diabetic eye screening. He began his research career at the Belgian Nuclear Research Centre. He holds a Ph.D. in Applied Biological Sciences from Ghent University and a Master of Science in Bio-Engineering from that same university.

In a study of more than 10,000 participants, with follow-up of over 10 years, smaller retinal arterioles were associated with a significantly higher risk (29%) of developing hypertension. Wider retinal venules were aso linked with increased cardiovascular risk[1].

This has been taken further in other studies. A study published in 2016 identified that narrowing of the arterioles and the widening of venules (changes in vessel width calibers) were linked with different cardiovascular outcomes, which included atherosclerotic cardiovascular events up to different cardiovascular disease endpoints, like heart failure stroke and even death caused by cardiovascular disease[2]. The researchers went on to use the dimensions of the vessels as an additional risk classification mark (the Pooled Cohort Equation or PCE score) and classify patients with a PCE score according to low risk, medium or high risk. This is obviously important in follow-up of patients with significant risks. There is a link between venule width, hypertrophy and worse diastolic and systolic function[3].

Prediction power

Deep learning and artificial intelligence (AI) are beginning to come to the fore in identifying clinical patterns obtained with digital retinal images.

For example, in another study, a significant association was found between information that was extracted using deep learning from the fundus image and the arterial calcium score[4].

"This is really interesting, because you get the same information from this fundus image, as you can obtain from a CT scan," added Prof. De Boever. "The researchers used a new risk factor for this rating – the retina coronary artery calcium (RetiCAC) risk score – to classify patients into risk categories. And they identified that those patients could really benefit from having an additional fundus image."

Prof. De Boever is very positive about the potential of AI in this context:

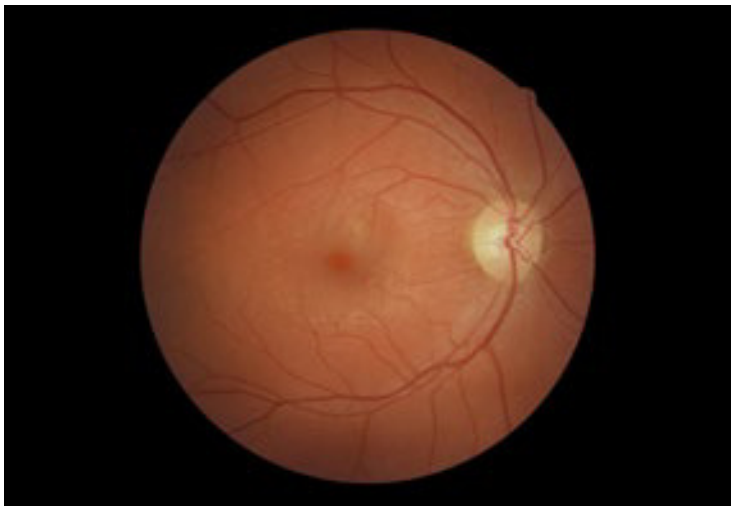
"There's a lot of very promising research about algorithms with an excellent prediction power, but the challenge is now to make the translation to the clinic, and to the applicability, and to take it from the research to the practice," he said.

Growing body of information

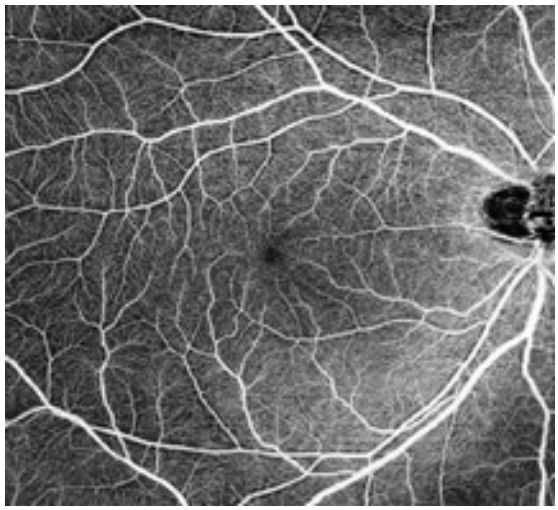
While much more research will be carried out in this field, eye examinations already show great promise in cardiology.

"Eye exams are fast and convenient (less than five minutes); and there are

Fundus image



OCT angiography scan



different image modalities that give information about structural and functional vascular information," said Prof. De Boever. "There is now a growing body of information available on eye exams as predictive tools in medicine and their use for cardiovascular follow-up and cardiovascular disease management."

Canon Medical Eye Care

Alongside its reputation as a leader in MRI, CT and Ultrasound technology, Canon Medical is becoming increasingly recognized in ophthalmology for its range of high-quality eye care imaging systems. In the context of using eye examinations to provide insights in cardiology, Canon's range of ophthalmic diagnostic equipment includes an advanced optical computed tomography angiography (OCTA) system – the Xephilio OCT-A1 and the Xephilio OCT-S1. //

References

1 *Ding et. al (2014); Journal of Hypertension, 32(2): 207–215.*
2 *Siedleman et. al (2016); Circulation, 134(18):1328-1338.*
3 *Chandra et al. (2019); European Journal of Heart Failure, 21, 1207–1215*
4 *Rim et al. (2021);Lancet Digit Health, 3: e306–16*

Canon Medical OCTA

Canon Medical's OCTA system – the Xephilio OCT-A1 and OCT-S1 -offer superior image quality and a host of automated features to optimize and simplify examinations. The system has a high scanning speed for short examination times, enabling increased efficiency and patient comfort.

Non-invasive examination, results within seconds

OCT Angio does not require fluorescein injection or pupil dilation, and the examination takes only seconds. SLO-based real-time tracking minimizes artefacts. Sophisticated image post-processing with 3D projection artefact removal enables excellent image quality.

Angio Expert with freely selectable layers

With OCT angiography even the smallest blood vessels can be observed in 2D and 3D. With Canon's OCT Angio software, you can freely select layers to create the preferred image. Layers can be defined based on automatic segmentation or as a custom offset. Canon Medical's Angio Expert software provides a complete set of manual and automated analysis tools including the latest innovation "Intelligent Denoise" a deeplearning imaging noise reduction software.

Investigating the Wider Impact of COVID-19 Infection

As the COVID-19 pandemic continues to affect everyone, The Johns Hopkins University in Baltimore, Maryland, US, is collaborating with Canon Medical on a ground-breaking study to investigate the wider clinical effects of the disease. The investigation is utilizing some of the most advanced technologies possible to reveal the impact of the disease on the whole body. Dr. Joao Lima, Director of Cardiovascular Imaging and Professor of Medicine at Johns Hopkins University, who is leading the study, spoke to VISIONS about this ground-breaking work.
Amongst others, Dr. Lima is collaborating closely on the study with Dr. Chia Liu, Senior Clinical Scientist at Canon Medical Systems Corporation, who has worked with Dr. Lima in previous years on a significant study into Atherosclerosis (the Multi-Ethnic Study on Atherosclerosis – MESA).

Longer term implications

Investigations into the clinical effects of novel corona virus of 2019 (COVID-19) have begun, because Dr. Lima's team wanted to gather some insight into what happens after the acute disease. This study is a morphological and quantitative analysis of COVID-19 sequalae.

"We have done a lot of studies in patients with acute COVID-19 and we wanted to investigate if patients with the disease would have sequalae in the myocardium, because from our studies in the acute cohort, it's clear that there is a process that involves the heart. We are also particularly interested in measuring fibrosis, and particularly, interstitial fibrosis in the heart, as a way to measure healing from an inflammatory insult. And, of course, not only for the heart, we thought also to image the lungs and the brain. We are in collaboration with our Neuro Radiology Department on this study." remarked Dr. Lima. "In addition, we are acquiring seed data to propose a study

Left: Dr. Joao Lima, Director of Cardiovascular Imaging and Professor of Medicine at Johns Hopkins University
Right: Dr. Chia Liu, Senior Clinical Scientist, Canon Medical Systems Corporation

"The images that we've been acquiring by ultra-short TE from the lungs are really remarkable. Our UTE images are among the best, if not the best."

Dr. Joao Lima
Director of Cardiovascular Imaging and Professor of Medicine
Johns Hopkins University, USA

to the US National Institutes- plural of Health (NIH) to follow these patients longer term. There are data suggesting that a few months after an insult, the patient can develop a fibrosis in the heart, and we would like to see the consequences of that."

Specially developed protocol

A protocol for the investigation was designed and developed through the combined expertise of Dr. Lima and his team and Dr. Liu. Some of the techniques are so cutting edge that many are not yet widely used in clinical practice. Along with imaging of the heart, brain, lungs and liver, there are also specific practical challenges posed by the nature of this particular corona virus. Before the public vaccination campaign began in the US, it was not always possible to carry out scans on patients, because of restrictions. In addition, acute COVID-19 patients often have a great deal of pain and other difficulties.

"With COVID-19, it's most important to keep the patient in the scan for the shortest possible time," remarked Dr. Liu. "Our eventual protocol for this study includes T1, T2 mapping on the heart and T1 mapping on the liver, with T2* (ultra-short TE) imaging on the lung. The T2* sequence has such a short TE, less than one millisecond, that we are able to see a lung parenchyma. Diffusion tensor imaging (DTI) is used for brain imaging. We also have lots of parametric mapping techniques that we apply with these patients."

"The images that we've been acquiring by ultra-short TE from the lungs are really remarkable," said Dr. Lima. "We are using the Canon platform for other studies as well, one of which is a pulmonary study. As we are part of a network of nine sites in the United States, we can compare images. Our UTE images are among the best, if not the best."

Basis for a wide range of understanding

The study and its data could provide the basis for further extension, or could provide useful key data for other research groups with an interest in this aspect of COVID-19, such as the longer term clinical effects of different variants of the virus. There is emerging evidence that other conditions, such as Type 2 diabetes, might result from severe or moderate infection cases of COVID-19 [1]. In addition, cases of COVID-19 that are seen in hospitals tend to be due to the severe pulmonary difficulties caused in some people. This may not be the only long term concern about the disease.

"What brings the patient to the hospital is the pulmonary involvement, but we wonder, for example, if a lot of patients that don't come to the hospital actually do have inflammation in the heart, and perhaps in the liver, but we just don't know about it. They could have maybe very little pulmonary involvement, but more cardiac involvement." said Dr. Lima." We want to use the sample seen in the hospital, but also at one point, include people who are symptomatic, but not 'pulmonary enough' to be admitted, and see if there are changes in those as well."

"There is also a syndrome called the 'long haulers'," he continued. "A percentage of people that had the disease appear to be limited afterwards. Those limitations are not yet understood. The patients are generally fatigued and can't perform anymore to the same level they used to perform. We are very interested in this group as well. It is also an important to find out if the disease limits exercise capacity, particularly in people who are top level athletes. In our institution, this relates to our lacrosse team. Several of the lacrosse players at Johns Hopkins have had COVID-19. There is a discussion to begin a study to look at those. And we may be involved at this center - the MRI center." //

Deep Learning Spectral - See beyond metal artifacts

Deep Learning Spectral CTA offers state-of-the-art image quality and improves the conspicuity and characterization of arterial structures. For patients with endovascular aortic stent grafts, SEMAR in addition to a Spectral DLR protocol will substantially reduce metal artifacts, and is beneficial for low keV monochromatic imaging. This protocol provides excellent depiction of the EVAR, with efficient assessment of endoleaks and graft integrity.

Patient history

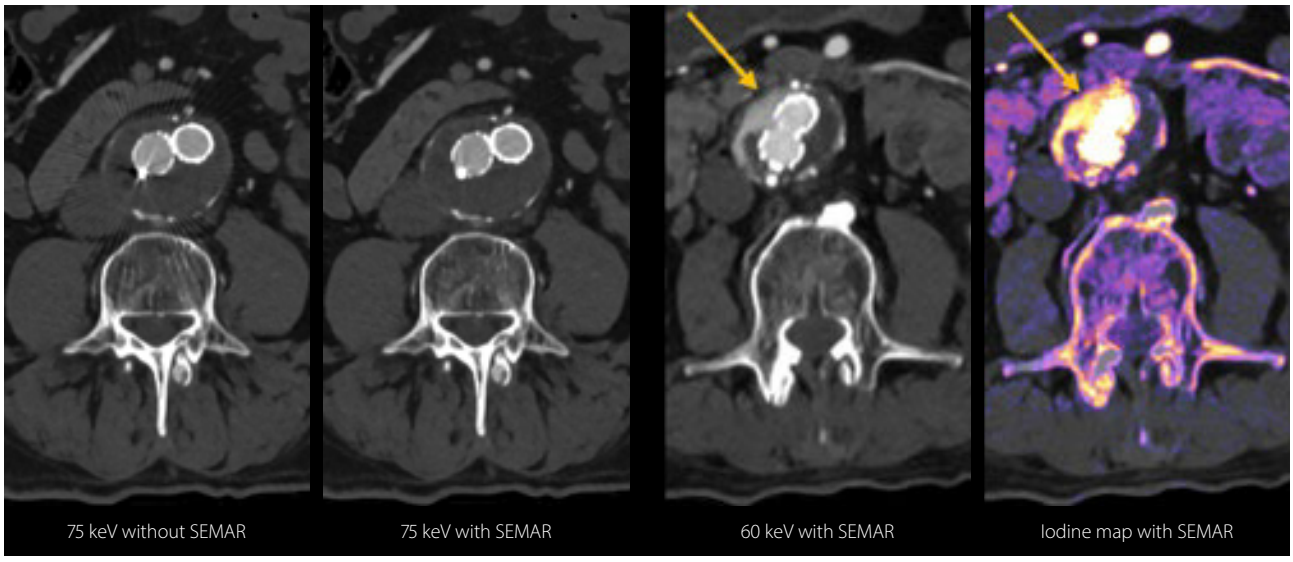
A 78-year-old patient presented for the one-month follow-up CT scan after an endoluminal stent graft repair of an abdominal aortic aneurysm.

A spectral CTA scan was performed on an Aquilion ONE / PRISM Edition and reconstructed with deep learning technology combined with metal artifact reduction to visualize endograft integrity.

"Deep Learning Spectral CTA offers state-of-the-art image quality and improves the conspicuity and characterization of arterial structures."

Prof. Mickaël Ohana MD, PhD
Nouvel Hôpital Civil
Strasbourg University Hospital,
Strasbourg, France.

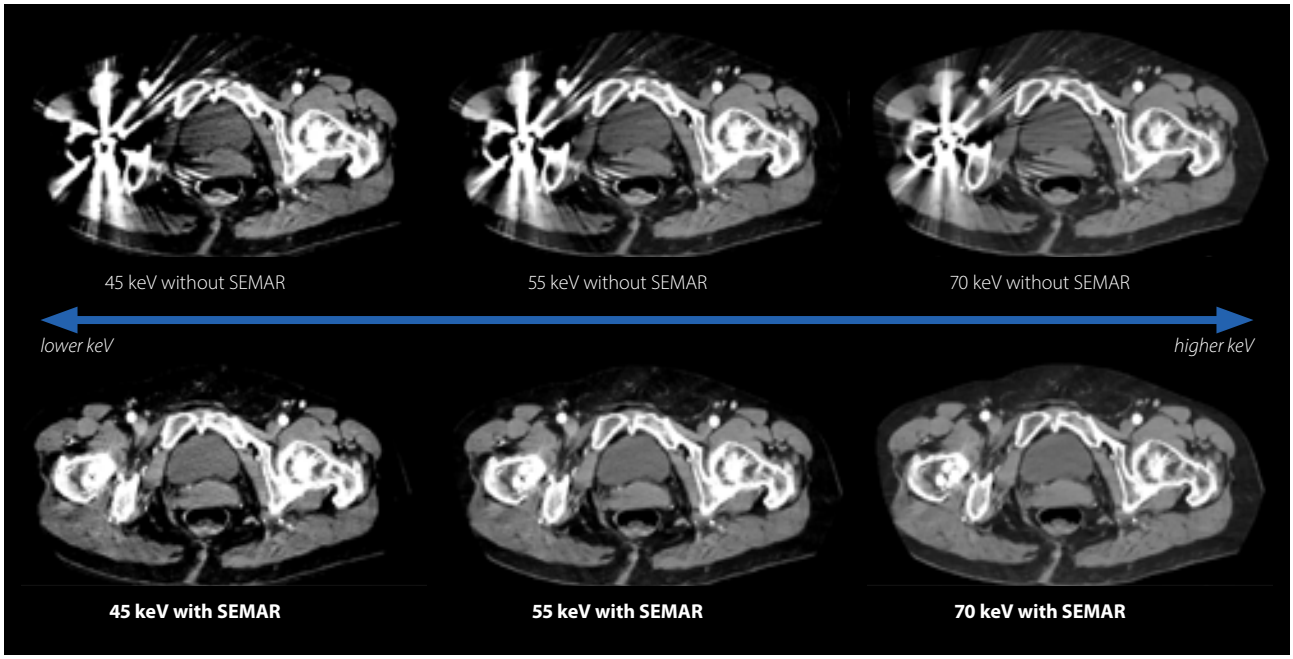
Results



Spectral images at 75 keV without Single Energy Metal Artifact Reduction (SEMAR) demonstrate significant streak artifacts, which may preclude the assessment of endoleaks and endograft integrity. Conversely, the spectral images at 75 keV with SEMAR show excellent metal artifact reduction with improved visualization of the adjacent soft tissue. Virtual monochromatic images at 60 keV and the iodine map with SEMAR clearly demonstrate the presence of a type II endoleak (arrow). The spectral outputs combined with SEMAR improve the ability to visualize the endoleak.

"SEMAR in addition to a Spectral DLR protocol will substantially reduce metal artifacts."

Prof. Mickaël Ohana MD, PhD
Nouvel Hôpital Civil
Strasbourg University Hospital,
Strasbourg, France.



Technology

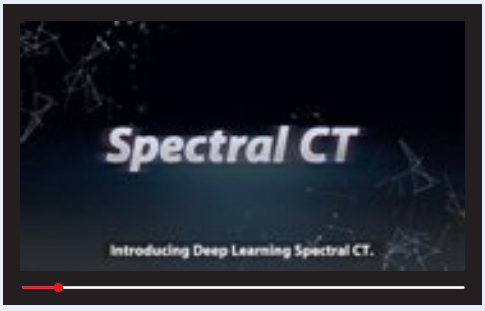
SEMAR is an innovative raw data-based reconstruction technique that can be applied to any spectral scan. Streak artifacts from metallic prostheses and endoprostheses are substantially reduced, resulting in clear visualization of adjacent anatomy.

SEMAR can be set up in the spectral scan protocol and applied automatically to all spectral reconstructions.

Conclusion

Deep Learning Spectral CT, in combination with SEMAR, substantially reduces metal artifacts in all spectral reconstructions. This allows clinicians to fully benefit from the increased iodine conspicuity in the low keV range (35-60 keV), to identify subtle endoleaks with greater confidence. //

Scan the QR-code or click HERE to watch the video



Your Feedback Drives Our Development

European Customer Survey Results

For decades Canon Medical has placed the Voice of the Customer (VOC) at the heart of its business. In 2015, we made steps to ensure faster and better response to customer feedback. Customer satisfaction research was increased from a once-a-year survey to continual monitoring in 'real-time', with the results of this used to implement actions to improve our services immediately. Since then we have been inviting our customers to evaluate their experience of our post-installation Training. In more recent years, we have also introduced customer satisfaction surveys on the Procurement, the Delivery & Installation and SOS Service.

The surveys enable us to gain better insight into customers' needs and the responses provide us with input for possible improvements. Thanks to your feedback, we were able to learn and grow as a company, resulting in the highest satisfaction score to date for our Delivery & Installation and Training surveys.

Although your satisfaction score is already at an extremely high level, you can rest assured that we will not sit still. We will continue to work on improvements in order to meet your changing needs and requirements as well as the general healthcare market conditions.

As we work towards further improvement of our services, your opinion is invaluable and we hope you will continue in providing us with your feedback!

This time next year, we will feature our 2022 Customer Survey results - Here's to another year of fantastic responses! //

Procurement

Average Satisfaction

9,2

Recommendation
78% rates a 9 or 10 when asked to what extent they would recommend Canon Medical (from 0-10) to others based upon their experience with **Procurement**

Delivery & Installation

Average Satisfaction

9,5

Recommendation
87% rates a 9 or 10 when asked to what extent they would recommend Canon Medical (from 0-10) to others based upon their experience with **Delivery & Installation**

Training

Average Satisfaction

9,4

Recommendation
80% rates a 9 or 10 when asked to what extent they would recommend Canon Medical (from 0-10) to others based upon their experience with **Training**

SOS Service

Average Satisfaction

8,7

Recommendation
77% rates a 9 or 10 when asked to what extent they would recommend Canon Medical (from 0-10) to others based upon their experience with **SOS Service**

Why do our customers recommend us?

Procurement

"Technical competence of the application specialist."

Austria, Ultrasound

"Relevance of sales arguments, the ergonomics of the device and the controlled after-sales services."

France, CT

"Professional, rapid response and excellent quality."

Germany, Ultrasound

Delivery & Installation

"Canon's professionalism and helpful assistance at every step of the project."

UK, CT

"The quality of the equipment and the technical/commercial support."

Spain, Ultrasound

"Excellent support."

Switzerland, Ultrasound

Training

"Good explanation during the training about the beautiful Ultrasound system."

Belgium, Ultrasound

"The training was very practical."

Germany, Healthcare IT

"The training was precise and straight to the point."

UK, CT

SOS Service

"Very good service from a very committed team."

The Netherlands, X-Ray

"Very good communication with Canon regarding the urgent matter we had at the time."

Sweden, CT

"Efficiency, kindness, professionalism and speed in assistance."

Italy, MRI

Three main reasons for choosing Canon:

1 **Quality of Services**

2 **Stable Partner**

3 **Technology Leader**

Canon Medical Systems Europe is the winner of the Customer Experience Awards 2021 in the category 'Continuous Customer Feedback'!

Read more in the News section of this VISIONS magazine.

From left to right: Dr. Frassi, Dr. Bernardara and Dr. Bernasconi from the Studio Radiologico Bernasconi, Seregno, Italy.

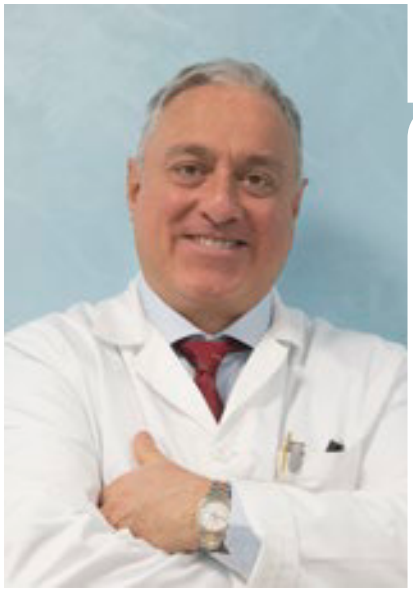
Interview with Dr. Paolo Bernasconi (the Studio Radiologico Bernasconi S.r.L., Seregno, Italy) about their experiences with the Vantage Elan / NX Edition 1.5T MR system from Canon Medical.

Vantage Elan / NX Edition - Exceeding Expectations

The Studio Radiologico Bernasconi S.r.L. is a specialist diagnostic imaging clinic founded 70 years ago in Seregno, Lombardy, an area in northern Italy with approximately 840,000 inhabitants. It was one of the very first healthcare facilities in Europe to install a new Vantage Elan / NX Edition 1.5T MR system from Canon Medical. The new system has enabled the clinic to provide even better image quality and has drastically reduced scan time across all anatomies. Radiologists at the clinic spoke to VISIONS to explain what a difference the Vantage Elan / NX Edition has already made.

Already renowned for providing some of the highest quality imaging services in Italy, the Studio Radiologico Bernasconi is an accredited private clinic that carries out work for the Lombardy region on behalf of the Italian national health service. Its areas of expertise include breast, oncology, musculoskeletal and dental diagnostics, and it handles around 70,000 services per year. With medical staff comprising of eight radiologists, anesthetists, medical radiology technicians, nurses and administrative staff, the clinic is headed by Dr. Paolo Bernasconi.

"We are well-known for delivering outstanding image quality and strive to achieve diagnostic confidence as a top priority," remarked Dr. Bernasconi. "To maintain this capability, we need top class technologies."



"Our new Vantage Elan / NX Edition has significantly improved the quality of all examination types and simultaneously reduced examination times."

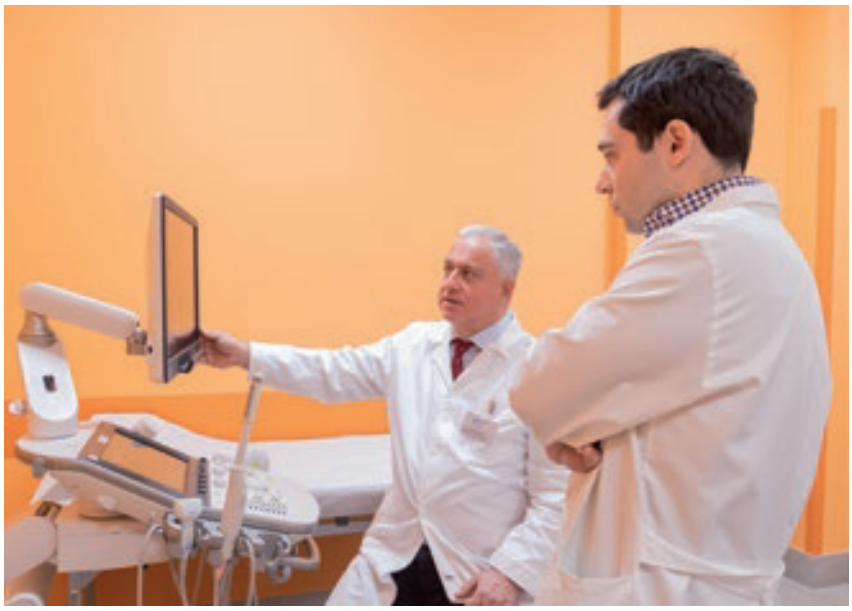
Dr. Bernasconi, Studio Radiologico Bernasconi, Seregno, Italy.

Benefits of 15 years of collaboration

This capability has been made possible by a 15-year relationship with Canon Medical.

"Our relationship with Canon started in 2007 when we bought a Toshiba Aplio XG ultrasound scanner. We were very satisfied with it and particularly appreciated the image quality and high reliability of the system," said Dr. Bernasconi. "In 2011, I decided to discontinue another brand of CT scanner and opted for Canon Medical's Aquilion 64 CT, which offered much better performance. And as I was fully satisfied with Canon, in 2012 I decided to replace the Aplio XG ultrasound scanner with an Aplio 500."

"A 'turning point' came in 2014 when our clinic purchased a Canon Astelion CT scanner, then in 2015, our first Aplio a and Xario ultrasound system also from Canon," he continued. "Finally, when we moved to our new facility in 2016, we replaced various brands of equipment with Canon systems, such as a Vantage Elan MRI in 2016, several ultrasound units like the Aplio i800 in 2017, two Aplio a450s, one i600 and an a-series in 2018. The Aquilion Lightning CT was installed in 2019."



Dr. Bernasconi and Dr. Papini from the Studio Radiologico Bernasconi, Seregno, Italy.

In 2021, the clinic partnered on a pilot project with Canon Medical to implement the world's first MR Deep Learning reconstruction technology: Advanced intelligent Clear-IQ Engine (AiCE). Which was installed on the new Vantage Elan / NX Edition MR system.

Supporting growth of an expanding healthcare facility

While expanding the scope and capacity of the clinic to meet increasing demand for high quality diagnostics, the progressive technology and structural modernization have necessitated relocation of the clinic to a more suitable space over the years.

In November 2016, it was moved to a 1600m^2 site, which was specially designed and built to accommodate the seven ultrasound machines, with five rooms dedicated to traditional radiology, a space for two Magnetic Resonance Imaging (MRI) rooms, a CT-room and ancillary areas for the influx of approximately 350 patients daily. In addition to diagnostic imaging, other rooms at the clinic are used for additional specialties, such as cardiology, heart surgery, gynecology,

orthopaedics, urology, general surgery, vascular surgery and psychiatry.

Throughout this development period, Canon Medical has provided support and service. "My experience from Canon Medical has been and still is, positive both in sales and technical support," remarked Dr. Bernasconi. "Compared to other vendors, one of Canon strengths is the direct contact with technicians in setting up the devices, which improves the efficiency in patients' throughput."

Significant improvements

Within a matter of months, the Vantage Elan / NX Edition has brought many benefits to the clinic in terms of productivity. The main new features are AiCE, Compressed SPEEDER and the combination of both technologies.

"Our new Vantage Elan / NX Edition has significantly improved the quality of all examination types, while simultaneously reducing examination times," said Dr. Bernasconi. "This is most noticeable in the abdomen and multi-parametric prostate exams. Productivity has definitely been improved as we could increase the number of examinations performed every day. We also achieve way superior performance."

"With the latest software upgrade, the machine's performance has improved considerably in terms of image quality/ diagnostic quality and acquisition time on individual sequences," added Dr. Attilio Bernandara, (Chief Radiology Tecnician). "The introduction of the AiCE system has meant that we can obtain images of a quality comparable to machines with a higher magnetic field, while remaining within the range of our working times. AiCE allows you to have a signal-to-noise ratio that enables you to have high-level diagnostic images in shorter times."

"With uncooperative patients, we can complete the examination with good quality images in a much shorter time using Compressed SPEEDER (CS)," added Dr. Bernandara. "We introduced previously unavailable sequences on our system (e.g. WFS DIXON sequence for FSE2D) and considerably improved the STIR sequences."

Dr. Bernandara has seen improvements in every sequence and anatomical region (body, neurology, musculoskeletal imaging etc.) with the Vantage Elan / NX Edition.

Dr. Bernasconi and Dr. Papini from the Studio Radiologico Bernasconi, Seregno, Italy.

"These were evident in the protocol for the prostate examination where the timing was reduced by almost 50 per cent while obtaining high-quality images," he said. "Neurological examinations have also undergone significant improvements, for example with Fast 3D mode, which has significantly reduced the time of angiography sequences while increasing image quality.

Better for patients

Patients at the clinic also experience significant benefits from the Vantage Elan / NX Edition. "From a patient perspective, the ability to obtain high image quality scans in less time is crucial for patients undergoing long time examinations, such as patients suffering from multiple sclerosis (MS) or oncology patients," said Dr. Papini Giacomo (radiologist).

"Now, we can routinely perform 3D FLAIR acquisition, not only in selected patients, such as 'post-op', but also as part of routine examinations. This increases our quality standards of care. We achieve shorter scan times while retaining overall good image quality, even in uncooperative patients. For example, this is particularly helpful in patients with spinal disc herniation or vertebral fractures, who find it hard to remain still due to sever of pain."

Space- and cost savings

In addition to the imaging and workflow benefits of the Vantage Elan / NX Edition, the system has an industry-leading small footprint, can be installed rapidly and helps towards optimizing operational costs for the hospital with a low power consumption. //

Find out more about Canon Medical's Vantage Elan / NX Edition at our website.

Canon Medical's Vantage Elan / NX Edition

The new functionalities for Vantage Elan / NX Edition are designed around customer and patients benefits. The demand fo reduced scan times as well as high-resolution images without sacrificing scan time remains the first priority for all radiologists. Advanced intelligent Clear-IQ Engine (AiCE) and Compressed SPEEDER successfully answered to this necessity. AiCE is applicable on 96% of the MRI sequences, where it simultaneously reduces scan times as well as improving image quality. Fast 3D mode - a technique to accelerate 3D studies by up to 50% - is now extended to cover Time of Flight studies and is available on the Vantage Elan / NX Edition.

An easy and simple workflow is always a priority for MR users. The new software empowers technologists with multiple functionalities like ForeSee View, KneeLine+, SpineLine+ and more. These techniques assure reproducible image quality, automate the scan planning process and avoid the need to re-plan and re-scan in challenging studies including cardiac and ankle examinations, for example.

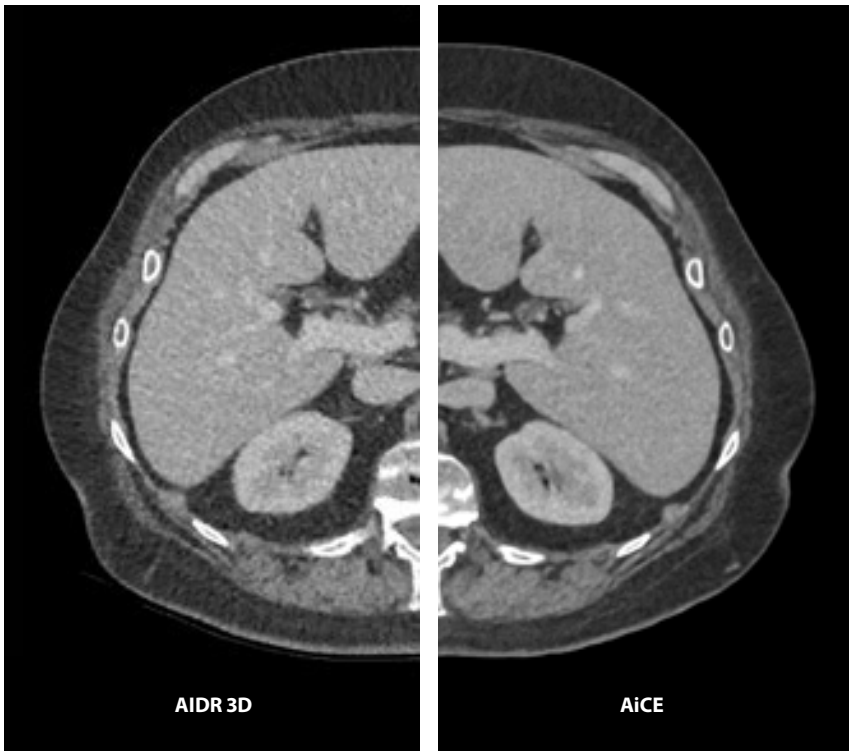
Dr. Bernasconi, Dr. Bernardara and Dr. Papini from the Studio Radiologico Bernasconi, Seregno, Italy.

Improving on Workflow with Deep Learning Reconstruction

Dr. Mark Kon, Consultant Radiologist at the Bradford Royal Infirmary, UK, has worked with Canon Medical's Aquilion Prime SP since the launch of the Second Edition and has seen the benefits from iterative reconstruction that are possible with Adaptive Iterative Dose Reduction (AIDR 3D). Powered by Altivity, the Deep learning reconstruction (DLR) in Canon's Advanced intelligent Clear-IQ Engine (AiCE) builds upon AIDR 3D technology to bring even greater gains in dose reduction, as well as image quality.

AiCE harnesses the enormous computational power of a Deep Convolutional Neural Network (DCNN) algorithm. It is trained to differentiate signal from noise, so that it can suppress noise and enhance signal. It can differentiate and produce images of high spatial resolution. Training involves advanced statistical model based iterative reconstruction (MBIR). However, unlike MBIR, AiCE deep learning reconstruction is part of Canon Medical's Altivity suite of solutions, leveraging AI to overcome challenges of image appearance and/or reconstruction speed when used in a clinical setting.

"From my perspective, AIDR 3D already delivers low dose imaging, but AiCE builds upon this to provide better quality images for the same or even lower radiation dose," remarked Dr. Kon.



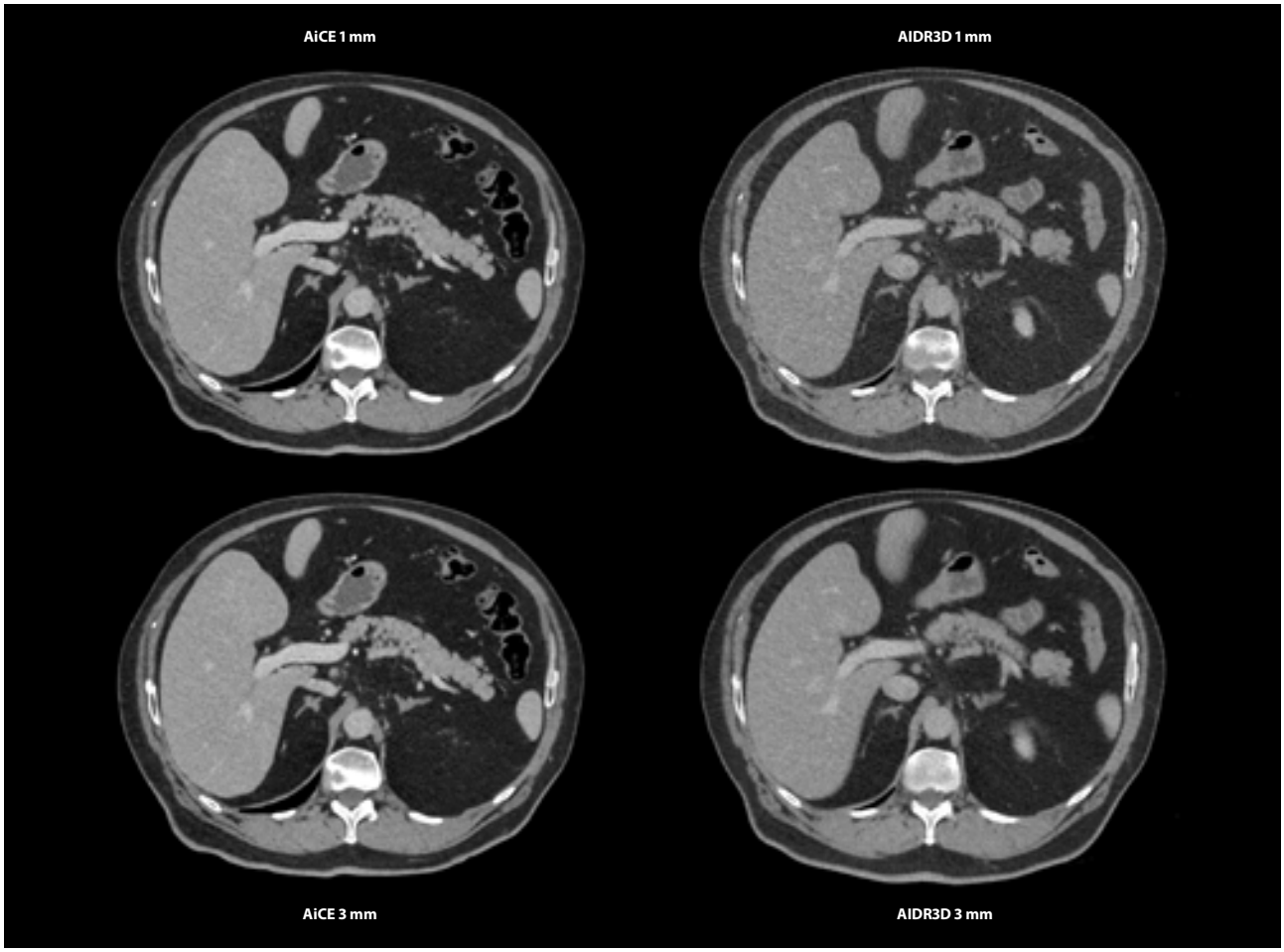
An all-in-one integrated solution for everyday use

The process of DLR requires a lot of computing power and time - far more than would be available at the local CT workstation.

"For me, the intelligent part about AiCE is that once DLR has learned the reconstruction process, the much more compact based algorithm can be packaged, transferred and installed with the local CT scanner. DLR processing, therefore, becomes truly integrated with the CT system and does not require further access to remote supercomputers by direct connection, or through the cloud," explained Dr. Kon. "This means that conventional CT rooms can accept Canon CT systems with AiCE as an all-in-one solution without depending on superfast cloud connectivity."

"AiCE has effectively replaced filtered back projection as the reconstruction engine, and integrates into the background of all our scanning," said Dr. Kon.

"We do not have to turn it on or off or select how much blending to choose. It is simply on all the time and built into every scanner and every examination, every day. It means that every examination takes advantage of DLR technology to achieve lower dose and better image quality."

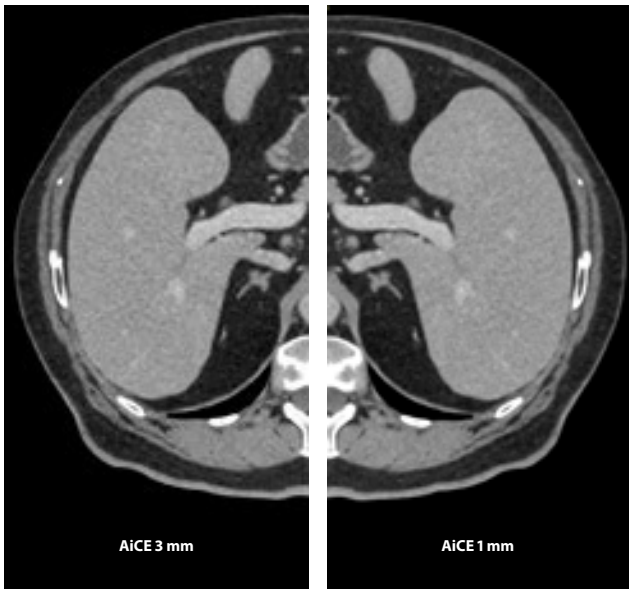


Training AiCE

The AiCE DLR is trained with high quality, advanced MBIR target images and learns to turn low-quality input data into low noise images that are sharp and clear. While in development, the AiCE DLR algorithm is taught to produce high signal-to-noise ratio (SNR) images through an intense training process. AiCE learns to differentiate signal from noise by training on selected, high-quality patient data sets that acquired with high tube current and reconstructed with all the benefits of state-of-the-art MBIR—including sophisticated system- and noise models, as well as a large number of iterations that are not possible clinically. As this time-consuming training process is completed before leaving the factory, the fully-trained AiCE DLR is able to work quickly in the clinic.

"With AiCE and a new PACS system, we only have to access one series of 1mm axials."

Dr. Mark Kon, Consultant Radiologist at the Bradford Royal Infirmary, UK.



Bradford Royal Infirmary, UK.

Noise-free images from thin slices

Dr. Kon has found the clear appearance of thin slice images one of the most remarkable benefits of AiCE in clinical practice. "Comparing AiCE 3 mm with AIDR 3D 3mm, there is much more noise in the AIDR 3D reconstruction," he said. "It has not surprised us that AIDR 3D 1mm is noisier than 3mm slices. AiCE 1mm images demonstrate significantly less noise than AIDR 3D 1mm images, but what is truly impressive is that 1mm AiCE reconstructions are almost as noise-free as AiCE 3mm reconstructions. While this does not sound like a big step, it has a profound effect on how we store, reconstruct images, and view multi planar imaging."

Streamlining workflow and data

Previously, Dr. Kon and his team would use 1mm axial sections to reconstruct and save to PACS, but would have to review images at 3mm, due to noise. They also had to save separate series of 3mm axial, 3mm coronal, and 3mm sagittal reformats, as well as 1mm and 3mm lung images.

"With AiCE and a new PACS system, we only have to access one series of 1mm axials.We now view noise-free one millimeter axial images and have instant access to 1mm reformatted sagittal, and 1mm coronal images. And with AiCE, even the lungs can be viewed without resorting to a separate lung reconstruction," he said. "This means a saving in PACS data storage, but more importantly, fewer series for the radiologist to open and close, improving on workflow."

Focused imaging

The low dose imaging achievable with AiCE enables Dr. Kon and his team to answer specific clinical questions with the lowest dose possible. "We use AiCE everyday for noise-free reconstruction, and to reduce radiation dose in every acquisition. Importantly, AiCE has enabled us to improve workflow for radiologists and has even encourages us to change the way we think by focusing our imaging on answering even more specific clinical questions," said Dr. Kon. //

From left to right: Andrea Kleger, Technician, Daniel Ivan, Veterinary Radiologist and Ylva Heidrich, Veterinarian (Anicura AOI Center, Switzerland

Opening up a New Era of Veterinary Diagnostic Imaging

The Vantage Elan 1.5T MR pushes neurological examinations and paves the way for new studies in veterinary patients, specialists at the Anicura AOI Center in Switzerland told VISIONS.

Zug means train in German. As images of railway tracks, green valleys and blue skies spring to mind, the name of a small region in Switzerland may also linger in memory.

The Zug canton is one of the smallest Swiss cantons. With a name that so vividly evokes travel, it can't be surprising that about 30% of the population comes from abroad. It's also no wonder that the team at the Anicura AOI Center in Hünenberg speaks eight languages.

The clinic cares for companion animals from all over Switzerland and beyond, being one of the few centers to offer both imaging and oncology services in Europe.

"We're quite a unique setup in the European private veterinary market," said Andrea Sumova, managing director and medical physicist at the Anicura AOI Center. "Besides university centers, there aren't that many places that provide the whole imaging modality portfolio and a linear accelerator under one roof".

Patients include cats and dogs, but also rodents, rabbits and exotic pets. A couple of weeks ago, the team even tended to a python for radiation therapy.

"We couldn't offer the full package to our patients. Now with that MR system, we can. It was the best choice for our clinic."

Daniel Ivan, Veterinary Radiologist at the Anicura AOI Center in Switzerland.

"In veterinary medicine, you never get a dull moment," Veterinarian Radiologist Daniel Ivan said. "Many of the more exotic cases work out better than expected thanks to the owner's cooperation, but we also have our tricks. For example, if we want to restrain a snake, we can get them to crawl into a plastic pipe. Most snakes will instinctually go inside, allow us to take the required imaging studies, while not being able to turn and flex around your arm or even bite you."

The clinic employs a variety of profiles that all together advance veterinary medicine. Besides the radiologist the team consists of a double board-certified specialist in oncology and radiation therapy, a neurologist, a certified medical physicist, three veterinarians, an imaging technician and nurses complete the team.

Daniel Ivan is a trained resident of the European College of veterinary Diagnostic Imaging, preparing for his

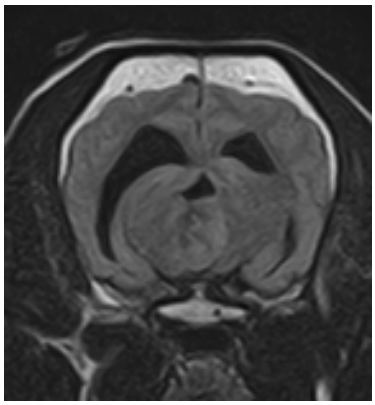
Ylva Heidrich, Veterinarian at the Anicura AOI Center in Switzerland.

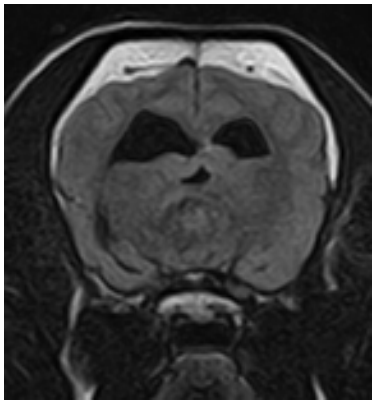
final certification. “I started working with an old 0.2T system that was originally designed for orthopedic imaging in humans, and then I worked all the way up to 3T MRIs.”

For the past three months, he’s been using the Vantage Elan 1.5T MR system in daily practice and can hardly hide his enthusiasm. “The Vantage Elan opens up a new era for us” he said.

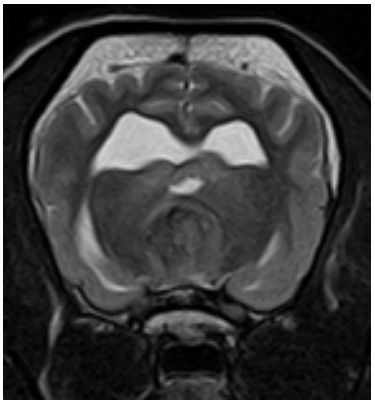
While CT is used for planning, bleeding or head trauma, MRI is the gold standard for the central nervous system. A high field system can make all the difference. “The great value of a higher field strength magnet is that it offers shorter examination times and large field of view, with great resolution. All these factors combined with the flexibility of the coils, make our work easier and improve our diagnostic capabilities”, Daniel explained.

Scan time must kept be as short as possible in patients in a critical or unstable

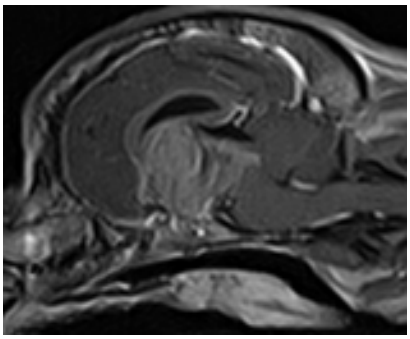




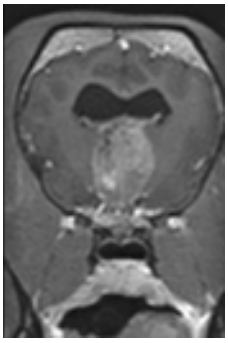
Axial FLAIR.



Axial T2.



Sagittal 3D T1 (MPRAGE).



Axial MPR from 3D T1 (MPRAGE) scan.

Canon Medical's Vantage Elan at the Anicura AOI Center in Switzerland.

The Vantage Elan is a robust and versatile MRI system that can be used for basic to advanced veterinary imaging applications.

On board are also a range of advanced imaging techniques like diffusion weighted imaging for example in oncology and neurology (i.e. early stroke detection), susceptibility weighted sequences i.e. for detecting even small microbleeds, a range of non-contrast and contrast enhanced MRA sequences and more.

It also offers a range of acceleration techniques to speed up the examination while maintaining outstanding image quality, has homogenous and robust fat suppression techniques and can be used for imaging very small (i.e. a feline brain) as well as large FOV's (i.e. when imaging a full spine of a large canine) in a very user-friendly manner thanks to the intuïtive user interface.

The Vantage Elan is also compatible with next-generation techniques like Artificial Intelligence (AI) based noise removal and compressed sensing scan acceleration technology.

condition, considering that anesthesia needs to be induced in veterinary patients in order to restrain movement during examination.

"We are frequently under time pressure when performing a study", Daniel said. "We're not here to just create images. Reducing scan time can make a big difference: sometimes reaching a diagnosis or not, sometimes even life or death."

The Vantage Elan has considerably reduced scan time. With the new protocols, a brain examination in small animals now takes about from 20 to 40 -50 minutes and a spine examination, 15 to 20 minutes from start to finish.

"It's extremely fast. If we're working with a field of view of 50 cm or over in a medium sized dog; with the correct positioning, we can acquire overviews of the spine in sagittal plane, in great detail, in a couple of minutes. Combined with some dorsal and transverse sequences, diagnosis is very quickly achieved in the majority of cases."

Going to soft tissues and beyond

The Vantage Elan does not only enable to examine patients with general brain and spine pathology, but also certain muscular conditions and joints, such as the as the shoulder joint or stifle joints.

"I'm very happy with the equipment and our cooperation with Canon Medical," Daniel Ivan said. "We're exploring the possibility to expand some of our current studies. With an MRI scanner this advanced, we are getting new ideas."

"We're very happy with the cooperation with Canon, they were here if we had questions, before, during and after the installation."

Andrea Sumova, managing director and medical physicist at the Anicura AOI Center in Switzerland.

Diagnosing tendon lesions in small joints can for instance be chal- lenging. All of these situations can be tackled with the Vantage Elan, thanks to the great setup of the coils, a key component in that piece of machinery.

"Older machines we worked with were not very well adapted to our patients, because of the way the technology was delivered," he said. "Although originally not dedicated to veterinary care, Canon Medical's Vantage Elan coils work very well for us and are easy to adapt to our needs."

Sequences performed with the Vantage Elan also enable to depict the nerve roots in the spine.

"The 3D MPRAGE is very nice to image our spinal patients, especially those with pathology in the lumbar spine ".

The best is yet to come, as those extremely fast sequences could help perform vascular imaging, an increasingly explored, yet underdeveloped field in veterinary medicine.

Another benefit of the equipment is that it's very quiet. "With various high field machines, sequences can get extremely loud. While we are trying to compromise and keep a superficial level of anesthesia, noise can be a stimulus. Less noise is great for everybody in and around the machine".

The team also appreciates the capacity to obtain very good quality 3D images, allowing for multi planar reconstructions. Slice positioning can be difficult due to the wide variations in patient sizes and weight. "Receiving thin slices with high resolution in a decent time really improves diagnosis."

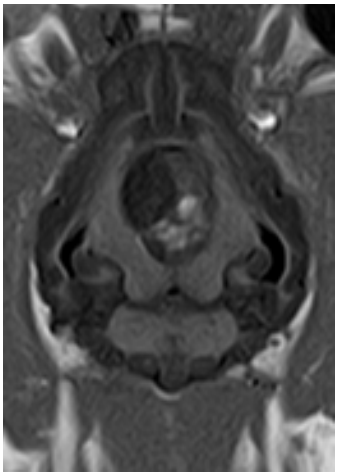
The user-friendly interface is a delight. "Not having to worry about various bugs or issues is a relief," said Daniel Ivan.

The cooperation with Canon is just as easy. "We're very happy," Andrea Sumova said. "They were here if we had questions, before, during and after the installation."

"Everything I was used with a 3T, I got it with a 1.5T," Daniel Ivan said.

"This clinic, without and MRI, couldn't offer the full package to our patients. Now, with this system, we can. It was probably the best choice for us and I'm happy we didn't settle for less. Judging the relation with Canon and the technology built in this machine, makes me feel that we are future-proof too." //

Andrea Kleger, Ylva Heidrich and Daniel Ivan.



Dorsal Real IR.

MR Elastography

Creating a New Imaging Modality to Address a Longstanding Medical Need

At RSNA 2021, Canon Medical announced the partnership with Resoundant to incorporate MR Elastography on the Canon MRI platforms*. This MR technique can detect and stage liver fibrosis. Liver fibrosis is the formation of scar tissue and affects the functioning of the liver. With the increasing incidence of obesity and type 2 diabetes, also the prevalence of liver fibrosis is growing. Before the onset of fibrosis, the patient often has a fatty liver. If there is no inflammation or tissue damage yet, this fat buildup in the liver can be reversed with lifestyle changes. Therefore, it is important to quantify the fat content of the liver and intervene in a timely matter. Canon Medical's Fat Fraction Quantification Application can provide this information of the liver in a single breath-hold. MR Elastography and Fat Fraction Quantification have become two essential techniques is the management of liver disease.

In this article written by Michael Kalutkiewicz, MA, Vice President Global Policy & Communications at Resoundant, Rochester, MN, USA, which is a an article from the free digital book of Olea Medical 'Spin to the Limit: MRI Physical and Principles Challenges', you will learn about these two MR techniques.

For centuries, physicians have used a physical examination technique known as palpation as an essential tool in clinical medicine. This enduring diagnostic method is remarkably effective because many disease processes cause large changes in tissue stiffness that can be readily easily perceptible through simple touch.

Despite its traditional place in medicine, palpation is a subjective technique, applicable only to regions of the body that are accessible to touch and limited in its ability to reveal small changes that may signal early disease. Although advanced medical imaging technologies like MRI and CT have revolutionized diagnostic medicine, traditional imaging protocols unfortunately are not capable of revealing the underlying properties of palpation: the mechanical stiffness of tissue.

To address this need, a team led by Richard Ehman, MD at Mayo Clinic, invented a technology called Magnetic Resonance Elastography (MRE)[1]. Their goal was to enhance the medical standard of palpation with the diagnostic power of medical imaging by developing a practical technology capable of sensitively and quantitatively assessing the mechanical properties of soft tissue in any area of the body.

The team focused on using mechanical vibrations as a probe to measure tissue stiffness. When a shear wave propagates in a medium, its wavelength is determined by the viscoelastic properties of the material. Dr Ehman and his team set out to find a way to visualize propagating mechanical waves inside the body using MRI.

This goal was extremely challenging, because such waves only displace tissue by a few nanometers. After extensive research, the team succeeded in developing MRE – a novel MRI technique capable of reliably imaging mechanical waves inside the body with extraordinary sensitivity[1].

Results demonstrated that by synchronizing motion-sensitizing gradients with applied waves, cyclic motions as small

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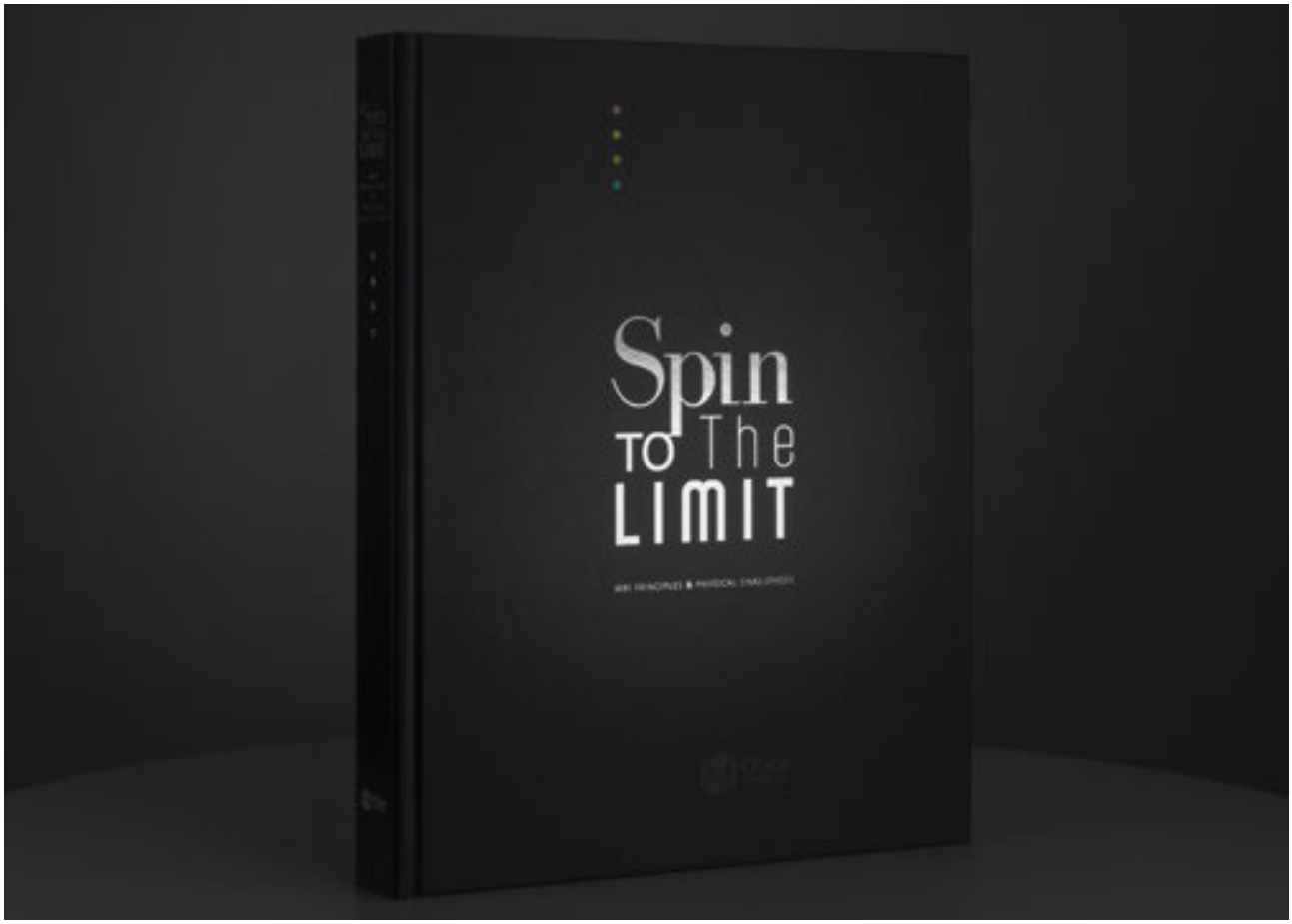

Scan the QR code or click HERE if you want to read more about the history, physics, applications and future of MRI in the book: 'Spin to the Limit: MRI Physical and Principles Challenges' (free of charge) of Olea Medical.

as the wavelength of light could be selectively imaged *in vivo*, even in the presence of physiologic motion[1].

The Mayo Clinic team further developed novel mathematical techniques to process the wave images in order to create cross-sectional maps quantitatively displaying the stiffness of tissues and organs in the body. They first reported these discoveries in the *Science* journal in 1995[1]. After more than 10 years of further research and development involving talented teams from all over the world, MRE was validated and the technology successfully translated into clinical practice. In 2009, MRE was cleared by the US FDA and, since then, the technology has been installed on more than 1500 MRI systems around the world.

MRE technology is now provided by MRI manufacturers as an option that can be installed on virtually any conventional MRI system. The installation includes unique acquisition and processing software, as well as specialized hardware to apply vibrations to the body. In order to ensure standardization of MRE technology, the Mayo Clinic founded Resoundant, Inc. to assist MRI manufacturers in implementing their versions of MRE. The specialized hardware used in all current regulatory approved MRE systems is designed and manufactured by Resoundant.

How MRE Works

An MRE examination is accomplished in several steps, with a specific protocol depending on the purpose of the exam. The most frequent current indication for MRE is to evaluate liver disease – MRE has been established in the literature as the most accurate non-invasive approach for detecting and staging liver fibrosis.

In an MRE exam of the liver, a small plastic device is positioned over the patient's right chest wall to deliver gentle low frequency vibrations during the scan, creating propagating mechanical waves in the liver. The vibrations are not uncomfortable, and the exam is well tolerated in routine clinical practice.

A specialized MRE pulse sequence is used to acquire images showing the propagation characteristics of the applied shear waves in the liver. The imaging time is very brief, typically requiring 1 to 4 acquisitions of about 15 seconds. Most scans are complete in under 2 minutes.

In the final step, the scanner automatically analyzes the wave images, using advanced mathematical algorithms to create cross-sectional images that quantitatively display tissue stiffness, using a standardized color scale. The images are sometimes called "elastograms" (Figure 1). In more formal engineering terms, the images display the magnitude of the complex shear modulus of the tissue.

In the final step of the examination, stiffness values are analyzed and interpreted by a radiologist.

The Unique Role of MRE in Evaluating Liver Disease

The advent of a way to noninvasively assess the mechanical properties of tissue has proven timely, as chronic liver disease has burgeoned into a major health problem worldwide[2]. While many conditions lead to chronic liver disease, the leading cause of end-stage liver disease is nonalcoholic fatty liver disease (NAFLD), which is now thought to affect 25% of the global population[2]. This condition is characterized by elevated liver fat content. About 12% of people with NAFLD will progress to develop chronic liver cell injury and inflammation, known as non alcoholic steatohepatitis (NASH). Many patients with NASH will develop liver fibrosis in response to chronic liver injury and, as a result, approximately 1-2% of people with NAFLD will progress to develop cirrhosis (end-stage liver disease)[2].

This progression of hepatic fibrosis is often clinically silent until it progresses to high-mortality end-stage cirrhosis. The early, subtle changes in liver stiffness are undetectable to traditional palpation, while blood-based markers lack the needed specificity[3]. This is unfortunate, since if fibrosis is diagnosed early, lifestyle interventions are highly successful in halting[4] and in some cases even reversing the condition.

When advanced fibrosis or cirrhosis is suspected, liver biopsy is the standard diagnostic method for detecting liver fibrosis. But liver biopsy is expensive and invasive. Moreover, biopsy's approach of sampling just 0.002% of the liver is greatly affected by sampling error, as fibrosis progression is heterogeneous in nature. In addition, liver specimens are evaluated using a subjective grading system which is affected by substantial inter-observer variability. Given these challenges, it has been estimated that upwards of 30% of biopsies may lead to an inaccurate diagnosis[5].

To fill this diagnostic gap between early disease and end-stage cirrhosis, two MRI techniques have emerged as new Gold Standards. Multiple studies have established that MRE has the highest diagnostic performance among non-invasive techniques[6] for detecting and staging liver fibrosis. In parallel with the advent of MRE, significant improvements have been made in longstanding MRI-based methods for quantitatively assessing liver fat, often represented as "proton

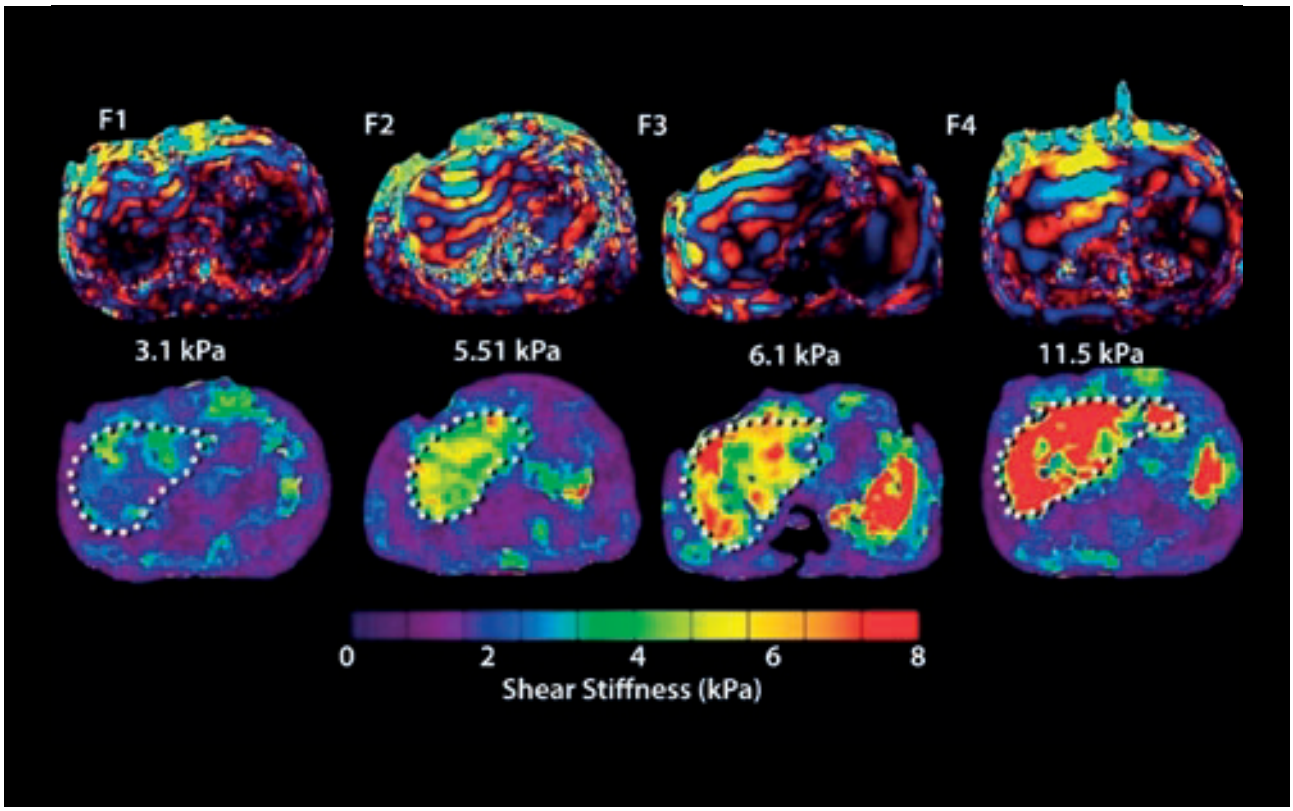

Figure 1. Wave images (upper row) and elastograms (lower row) from an MRE exam depicting progressive stages of liver stiffness and the corresponding fibrosis stage.

density fat fraction" (PDFF)[7]. It is now possible to acquire data that can be processed to generate quantitative PDFF images in a single MRI acquisition lasting less than 20 seconds. Like MRE, PDFF techniques have been well-validated in dozens of studies against paired biopsies[7], with high degrees of inter-reader agreement and repeatability.

Both techniques have also been standardized across various vendor platforms and field strengths, facilitating their use as drug development tools in clinical trials[8] and in clinical practice. Neither technique is significantly affected by common co-morbidities that can cause failure in complementary ultrasound-based techniques, such as obesity or ascites.

Ready to Meet a Global Challenge

Together, MRE and PDFF have already been recognized in professional clinical guidelines[9-10] as front-line tools for liver assessment in patients with suspected chronic liver disease – particularly NAFLD, and the more severe NASH. Those that progress to increased liver inflammation and fibrosis represent 25% of these patients, putting them at significantly increased risk for liver-related events as fibrosis progresses. An accurate assessment of steatosis and fibrosis using PDFF and MRE, respectively, will be an essential part of patient management.

Perhaps most interestingly, their rapid acquisition time allows practices to experiment with them as a fast, low-cost exam for liver assessment. Both PDFF and MRE sequences can be done in just a few breath-holds, making the total exam time well under 10 minutes in most circumstances. In the US, the Centers for Medicare and Medicaid Services (CMS) issued a reimbursement option for standalone MRE (not as part of a full abdominal MRI workup). The cost is just $240 – representing perhaps the first low-cost, rapid MR exam that can be deployed to address a specific global health need. At the Mayo Clinic, this protocol is being called the Hepatogram[11] and is largely replacing the need for liver biopsies – resulting in further systemic savings and an improved patient experience.

The advent of tools such as MRE could represent a new era in MR imaging, where rapid, low-cost protocols are utilized to answer very specific clinical questions. Just as the idea of exploratory surgery has been replaced by advanced imaging, general MRI exams to search for diffuse answers may be needed less frequently. As acceptance and adoption of these specific approaches grow, it will no doubt usher in an exciting and innovative era of MRI. //

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Adjusting Contrast Media Dose to Compensate for Changes in kVp During Portal Phase Liver CT

Matthew Benbow, Superintendent Radiographer CT and MRI Royal Bournemouth Hospital, UK

Appropriate contrast enhancement of organs in CT is key to promoting accurate diagnoses. With abdominal imaging it is particularly important to ensure the liver is appropriately enhanced as cancers may metastasise within it. As the vast majority of the hepatic blood supply comes from the portal vein, the portovenous (parenchymal) phase is often the most diagnostically useful due to the tissue being at its most homogenous, making anomalies easier to distinguish.

Many factors affect contrast media enhancement. Much has been written on individual contrast dosing, e.g. weight-based and also accurate scan delay times, but an area often overlooked is the effect from the choice of kVp used. With the advent of more efficient detector technology alongside iterative reconstruction techniques, CT exposure levels have decreased, so this has led to the opportunity to employ lower kVps. Altering the kVp with a corresponding amendment of the modulated tube current (mA) can achieve a constant image quality in terms of signal to noise ratio, but there are considerations that need to be understood before this is done:

a) The patient dose may be affected despite the overall image quality being maintained, i.e. lowering the kVp with a corresponding (possibly automated) raise in mA to maintain image quality, may actually deliver a higher patient dose.

b) All CT x-ray tubes have a maximum mA achievable. Lowering the kVp may result in the mA 'topping out', i.e. to maintain image quality the scanner would need to deliver more mA than the tube can achieve. Continuing with this scan may therefore result in an under exposure and poor signal to noise ratio. This is more often a consideration before lowering the kVp for larger patients.

c) The lower the kVp the stronger the effect will be from IV contrast media. Bae 2010[1] discusses that using lower tube voltages will result in higher CT attenuation because the x-ray output energy is closer to the iodine k edge of 33 keV and that iodine concentration of 1 mg of iodine per milliliter corresponds to contrast enhancement of approximately 30 Hounsfield Units for 100 kVp but 40 Hounsfield Units for 80 kV. This confirms that we should take kVp into consideration what deciding upon a suitable contrast dose to administer.

Generally only a small number of kVp settings are available. Using the Canon CT system, the Aquilion ONE / GENESIS Edition, for example there are four – 80, 100, 120 and 135. Routinely, we seek to use 100 kVp for adult abdominal imaging. For larger patients however, we may need to switch up to 120 kVp to ensure we deliver an adequate x-ray exposure to ensure image quality. When doing this we instruct the radiographers to make an additional adjustment to the contrast media delivered to try to maintain adequate liver enhancement. Conversely, for patients with poor renal function, we sometimes switch down to 80 kVp which enables us to reduce the contrast dose delivered whilst still maintaining adequate enhancement, and thereby help protect the kidneys.

So whilst we know there are are image quality and clinical safety benefits in adjusting kVp and contrast media, a measured relationship of the effect in our portovenous phase enhancement has never been established. The aim of this study is to more accurately measure the contrast enhancement differences seen at each kVp, and thereby establish a more accurate recommendation of the contrast dose adjustment that will most likely maintain the desired enhancement at each kVp.

Since 2011 we have been using weight-based contrast dosing for portal phase abdominal imaging. The original study was carried out by Benbow and Bull in 2011[2] to establish a weight-based look-up table (Figure 1). Compared with the previous 'fixed 100 mls for all' technique, it successfully raised the number of patients who received optimum portovenous liver enhancement (in the range set at 100 – 125 HU) from 43% to 80%.

Patient weight	Contrast volume to use (ml)
Up to 60 kg	70
60 to 70 kg	85
70 to 80 kg	95
80 to 90 kg	105
90 to 100 kg	115
100 to 120 kg	125
Over 120 kg	150

Figure 1.

The dosing suggested in the table was based on 350 mgI strength contrast media, and at the time it was formulated using a scanner optimised for 120 kVp , but with beam filtrations that have since been improved.

On a newer scanner, such as our current Aquilion ONE / GENESIS Edition, we now use a default of 100 kVp and so the look up table has evolved (Figure 2).

Figure 3.

Figure 4.

Patient weight	Contrast volume to use (ml)
Up to 50 kg	60
50 to 60 kg	70
60 to 70 kg	85
70 to 80 kg	95
80 to 90 kg	105
90 to 100 kg	115
100 to 120 kg	130
120 to 150 kg	140
Over 150 kg	160

Figure 2.

The radiographers' workflow is to assess the patient's weight, then deliver the appropriate dose (volume) of 350 strength contrast media. However, if the patient is larger, and requires a kVp of 120 to maintain an adequate overall radiation exposure, then they must switch up one weight category to ensure the patient gets more contrast media to compensate for the drop in contrast enhancement suffered by the kVp increase. If on the other hand the patient would benefit from being given less contrast (e.g. has poor renal function) then 80 kVp is utilised such that they can switch down one group. The question was therefore whether this change of one group, which results in a change of around 10-20 mls, was accomplishing the desired effect of maintaining optimal enhancement.

Study

The optimum portovenous liver enhancement had already been decided in a previous study to be 100-125 HU[1]. In bottled concentration, contrast media enhances considerably more than this of course, but during the portal phase it will have been significantly diluted with blood and shared throughout the body such that only a proportion will be within liver. So a phantom was required to simulate a liver loaded with optimal portovenous amount of contrast media. According to Andersen et al 2000[3], the average liver volume is around 1.3 to 2 litres, and so 1.5 litres of water were poured into a radiolucent vessel (sharps bin – Figure 3) and then small amounts of 350 strength contrast media were added and it was repeatedly scanned, firstly at 80kVp until an optimal 115 Hounsfield Units (HU) were measured. The solution was then rescanned at 100, 120 and 135 kVp and each enhancement recorded (Figure 4).

Next, more contrast media was added until 115 HU was achieved at 100 kVp. The solution was then scanned at 80, 120 and 135 kVp and the enhancements again recorded. This was repeated twice more by achieving 115 HU enhancement at 120 and 135 kVp. Whilst this is admittedly a crude phantom, it was felt that it represented a similar sized volume of fluid to a liver, infused with an amount of contrast media to offer desirable in-vivo portal phase enhancement, i.e. contained a similar amount of iodine per volume.

1.5 litres water	11 ml of 350	15 ml of 350	19 ml of 350	22 ml of 350
80	114.08 HU	148.18 HU	183.72 HU	210.61 HU
100	87.86 HU	114.47 HU	141.27 HU	161.10 HU
120	73.04 HU	93.22 HU	115.75 HU	132.49 HU
135	67.16 HU	82.49 HU	103.12 HU	116.71 HU

Figure 5.

Results

A target of 115 HU was chosen to be considered mid-range, and therefore optimum portovenous enhancement.

At 80 kVp it was found that it required 11 mls of 350 mgI/ml contrast media to be added to the 1500ml water to result in a CT enhancement of 115 HU. This mixture was then scanned at 100, 120 and 135 kVp and the HU measured and noted.

An additional 4mls of 350 mgI/ml, i.e. a total of 15 mls was required to reach 115 HU at 100 kVp. So as expected a stronger solution was required to maintain enhancement at 100 kVp compared with 80 kVp. This new mixture was then scanned at 80, 120 and 135 kVp and the HU measured and noted.

This process was repeated at 120 kVp which required a total of 19 mls of contrast media, and then at 135 kVp which required it to be increased to 22 mls of contrast media. The results are in tabulated in Figure 5.

So it can be seen that the solution strengths required to maintain 115 HU enhancement at each kVp were:

- 80 kVp – 350 x 11 mgI, or 3.85 g iodine in 1511 ml fluid, or 1 g in every 392 ml of solution
- 100 kVp – 350 x 15 mgI, or 5.25 g iodine in 1515 ml fluid, or 1 g in every 288 ml solution
- 120 kVp – 350 x 19 mgI, or 6.65 g iodine in 1519 ml fluid, or 1 g in every 228 ml solution
- 135 kVp – 350 x 22 mgI, or 7.7 g iodine in 1522 ml fluid, or 1 g in every 198 ml solution

So, at 135 kVp TWICE the iodine concentration (contrast dose) is needed to maintain the same enhancement as at 80 kVp.

How would we put this into practice to ascertain what changes we should actually make when needing to (or choosing to) raise or lower kVp?

Example 1

Assume we are to scan a large patient who requires a change from 100 kVp to 120 kVp. How much contrast media increase should be to be injected to result in the appropriate amount of contrast reaching the liver, and maintain the desired portovenous phase enhancement of 115 HU?

Let us assume the patient is 85 kg. Using our current weight-based look-up table we would inject 105 mls at 100 kV, with the aim to enhance the liver to 115 HU. From the results we can now assume that we would be loading the liver with 5.25g (or more if a larger liver) of contrast media, equating to 1mg for every 288mls of fluid held in the liver.

So lets us assume that our scanner mA modulation has told us that we are going to need to go up to 120 kVp to maintain image quality. We need to therefore load the liver with around 6.65 or more mg Iodine (depending on liver volume), i.e. 1 mg for every 228 mls of solution in the liver.

Therefore this suggests that we should inject proportionally more contrast media, i.e. 288 / 228 x 105mls = 133 mls of 350 strength contrast media.

Patient weight	Calculated contrast volume to use at 80 kVp (ml)	Existing established contrast volume used at 100kVp (ml)	Calculated contrast volume to use at 120kVp (ml)
Up to 50 kg	44	60	76
50 to 60 kg	51	70	95
60 to 70 kg	62	85	107
70 to 80 kg	69	95	120
80 to 90 kg	77	105	132
90 to 100 kg	84	115	145
100 to 120 kg	95	130	164
120 to 150 kg	102	140	176
Over 150 kg	117	160	202

Figure 6.

Using our standard rules we would have only increased by one weight category for a kVp increase, i.e. we would have given 115 mls, but this shows that in fact we may achieve better imaging by increasing two weight groups to give 130 mls. This would be a contrast dose increase of around 25%.

Example 2

We are about to scan a patient at 100 kVp, but have established a poor renal function, so decide to drop to 80 kVp such that we can give less contrast media whilst maintaining enhancement. How much can we drop by? Using our current system we would drop by one group.

Let's assume the patient is 65 kg. She would usually receive a weight-based dose of 85 mls to attempt to enhance the liver to around 115 HU. This equates to a dose of 1mg iodine for every 288 mls fluid, but at 80 kVp the results suggest that she would need only 1 mg iodine in 392 mls fluid. Therefore, this advocates we should be able to drop by 288/392 x 85 mls = 62 mls and maintain enhancement. Using our current rule of dropping one group, we would have only reduced to 75 mls, but in actual fact we could do much better by dropping two groups to give 60 mls. This would be a contrast reduction of around 30%.

So in general, we can infer some multiplication factors for kVp changing that should maintain the same portal phase enhancement as follows:

- Change from 80 > 100 kVp, increase volume by x 1.36
- Change from 100 > 120 kVp, increase volume by x 1.26
- Change from 120 > 135 kVp, increase volume by x 1.15
- Change from 135 > 120 kVp, decrease volume by 0.87
- Change from 120 > 100 kVp, decrease volume by 0.79
- Change from 100 > 80 kVp, decrease volume by x 0.73

As our default kVp is 100, the most useful two changes for us to consider are raising from 100 to 120 kVp for larger patients (we practically never need to go as high as 135 kVp), and, lowering from 100 to 80 kVp for patients with poor renal functions (though very low kVp is often only a realistic option for smaller patients where an adequate overall exposure can still be attained).

This table in Figure 6 shows that when looking to lower the kVp (green arrows) for lighter patients, for those under 60 Kg a change of one weight category (as currently done) is enough. However for middle weight patients (60 to 80 Kg) a change of two weight groups was likely to give a perfectly adequate enhancement.

When needing to raise the kVp for heavier patients (over 90 Kg) adjusting the amount delivered by two weight categories rather than one was also likely to offer better enhancement.

Practically, I therefore decided to implement a new rule to change by two weight categories instead of our existing rule of one, keeping the minimum adult delivery to 60 mls, and maximum as 160 mls.

Summary

Altering the kVp used for portovenous CT imaging has a significant effect on the contrast enhancement achieved. Adjustments in contrast dosing should be made to compensate where a change in kVp is undertaken – increase contrast dose for higher kVp, decrease contrast dose for lower kVp. The amount adjusted will likely vary for differing scanners as beam filtration is not the same for all vendors or scanner models. In this study, for our system, a change up from 100 kVp to 120 kVp required 25% more contrast to maintain the same enhancement. Similarly a change down from 100 kVp to 80 kVp allowed a 30% drop in contrast dose to maintain enhancement. The adjustment needed seems to be larger than we previously had been making. We have subsequently changed our practice in line with these findings.

Interestingly, a hypothetical adjustment (as we would never need to do this) from 80 kVp to 135 kVp would require somewhere in the order of a doubling of contrast dose to maintain enhancement. //

Matthew Benbow
Superintendent Radiographer CT and MRI Royal Bournemouth Hospital, UK

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Next Generation of AI-Enhanced Ultrasound Productivity

The new Aplio i-series / Prism Edition offers a whole new level of diagnostic precision and imaging capability for ultrasound and features a whole spectrum of flexible, AI-assisted productivity functions powered by Altivity, Canon's new AI brand. Clinicians from across the world are discovering the difference this advanced new system is making to their clinical practice by streamlining workflows, delivering fast and accurate results, and enabling more personalized patient care. Some of the first users in Radiology, Cardiology and Women's Health to adopt the new Aplio system shared their experiences on how it addresses previously unmet needs in their work.

Canon's Aplio i-series is a trusted, premium ultrasound platform with powerful imaging, quantification and advanced analysis capabilities for a wide range of clinical specialties. It is renowned for its consistently robust performance and efficiency across a comprehensive range of clinical applications.

The latest Aplio i-series / Prism Edition was launched earlier this year enabling users to achieve a new level in diagnostic precision.

What type of Artificial Intelligence (AI) technology is integrated in Canon's ultrasound machines?

Pattern recognition and the quantitative assessment of structures are important parts of reading diagnostic

Scan the QR code or click HERE to watch Canon Medical's video about the Aplio i-series / Prism Edition!

The system's new iBeam+ technology enables up to four times faster image processing to provide sharper images, better penetration and more clinical confidence – optimal conditions for AI-based technologies to be effective.

images and ultrasound is no exception to this. While expert users are able to consistently localize and characterize certain structures, it can be challenging for the less experienced sonographer. In addition, placing markers or tracing structures of interest for their quantitative assessment can be a time-consuming task, prone to errors or inaccuracies. Automated pattern recognition can therefore be useful to improve the workflow, quality, and consistency of exams for all users.

Machine Learning and particularly Deep Learning – a sophisticated AI method – can help to apply expert knowledge and skills to powerful algorithms that improve the recognizability of structures and simplify their quantification by automating the process. For this purpose, Machine Learning algorithms are trained with a large number of clinical cases, which have been evaluated by experts, in such a way that they can independently recognize or analyze certain structures. The training occurs at the factory before the algorithms are implemented in the product, so their behavior does not change.

Meeting new challenges

Ultrasound users are continuously challenged by a growing number of difficult-to-scan patients, increased complexity of cases and a growing demand for standardized documentation according to the guidelines issued by their respective clinical associations. Combined with an increased demand and shortened time per patient, sonographers are looking for ways to enhance efficiency, while at the same time improving their diagnostic confidence. Improved imaging technology creates higher resolution, which drives increasingly complex measurements and analysis that require time and skill. Through accurate automatic measurements on a number of parameters, the Aplio can provide clinicians with reliable information faster and more efficiently.

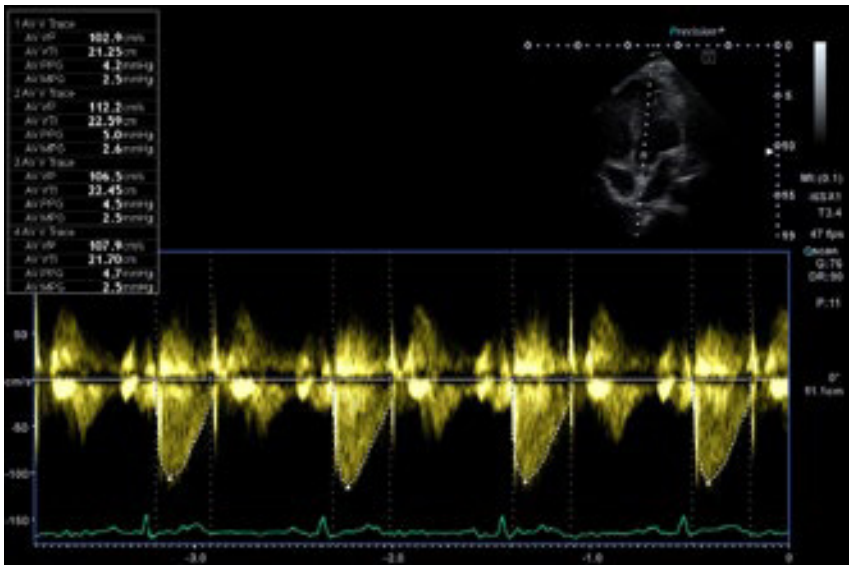
"In my clinical practice, the challenges comes from the patients. Obesity is an increasingly key issue and there are short time slots for the echocardiographic examination in ambulatory practice," remarked Professor Michel Zuber, formerly senior cardiologist at Cantonal Hospital Aarau, Switzerland. "Some years ago, it was not possible to get enough information from difficult-to-scan patients, as for example a patient weighing 125 kg, but now we can see that we have really good resolution with ultrasound, so we don't need an MRI to obtain a simple functional and anatomical assessment, even in very difficult patients."

"The new Aplio i-series from Canon helps me a lot, because we can get information from very difficult-to-scan patients in a short time. How? It is possible with automatic measurements due to Artificial Intelligence. That's the keyword and the future of echo too," he continued "We can get the workflow through the navigator, and this guides the examiner through the examination from view to view, and from mode to mode. So at the end you will not forget any measurements. We get very reproducible information from patients, such as ejection fraction or global longitudinal strain in one view or three-dimensional view, within a very short time. This guided approach is important to get always a full data set."

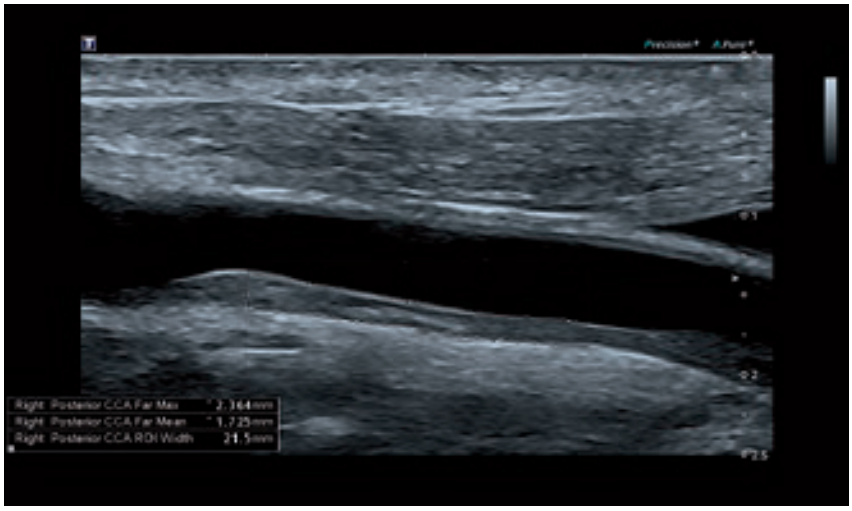
"It's very helpful to get information for my patients, such as ejection fraction or global longitudinal strain in one view, within a very short time, but in a very reproducible manner."

Prof. Dr. Michel Zuber
Othmarsingen, Switzerland

Auto EF LV/LA



Auto Doppler trace



Auto IMT measurement

Fast results made possible with accurate automatic measurements

Aplio achieves faster results through the use of accurate automatic measurements made possible by AI.

Measurement Assistant

Auto EF LV/LA

With conventional image recognition technology, automatic contour tracing of the endocardial border in noisy images with weak delineation is far less accurate than manual contour tracing performed by an experienced user. Machine Learning has been employed for Aplio to develop improved contour tracing algorithms to overcome this challenge, enabling faster and consistent analysis of all four heart chambers.

Auto Doppler trace

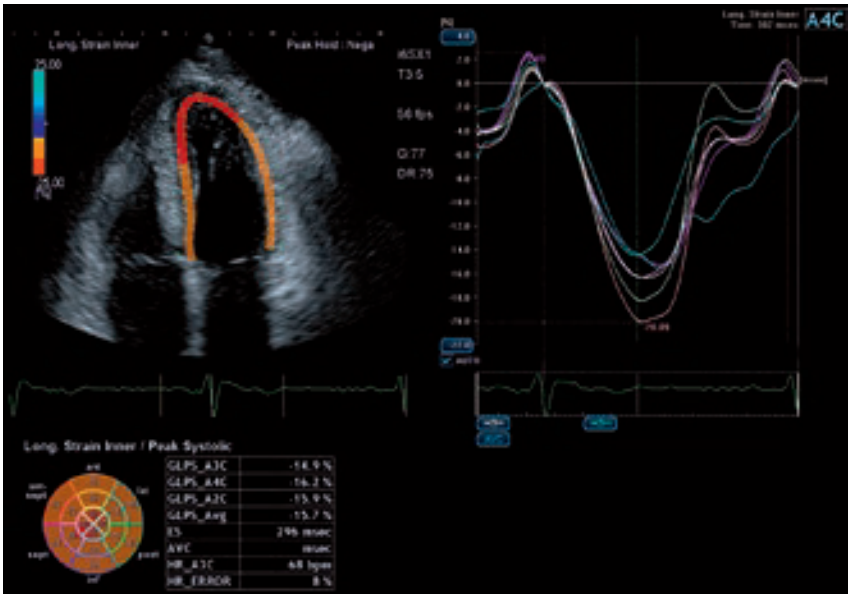
Machine Learning has also enabled the development of an automatic tracing function for Doppler waveforms. While conventional waveform tracing techniques have difficulties tracing steep slopes and separating artifacts from the waveform to achieve consistent and accurate tracing results, Aplio's AI-enabled algorithm allows multiple waveforms to be assessed, substantially increasing examination efficiency. Data obtained with a wide range of settings were included in training the Machine Learning algorithm to minimize operator dependency related to differences in for instance gain or scale settings.

Auto IMT measurement

Thanks to AI-enabled technology, Aplio allows the user to achieve accurate tracing of the intima media even in cases where layers cannot be distinguished clearly by eyeballing. Image analysis and tracing are performed at high speed, and the measurement results are updated immediately when the measurement ROI is moved using the trackball. Measurements can be performed at merely any relevant location.

2D/3D Wall Motion Analysis

The performance of 2D and 3D Wall Motion Tracking on Aplio, which is used for GLS and regional myocardial wall motion analysis, has been significantly improved by employing automation technology developed using Machine Learning. Aplio allows the user to perform wall motion analysis on each of the four cardiac chambers with single-click operation. While the system recognizes standard views (2ch, 3ch or 4ch) automatically, initial contours are drawn, and measurement results are displayed automatically. Right ventricular analysis includes determination of TAPSE and FAC for a quantitative estimation of right ventricular function.



2D/3D Wall Motion Analysis

Smart Area Indication for OB

Deep Learning-empowered Smart Area Indication for OB applications can help obstetricians to identify standard anatomical views for faster workflow and enhanced uniformity in exam results. Aplio's intelligent algorithms can automatically identify standard anatomical structures used for the evaluation of gestational age and fetal growth, speeding up workflow and helping departments to enhance productivity while improving the quality of their services.

Smart Area Indication for OB

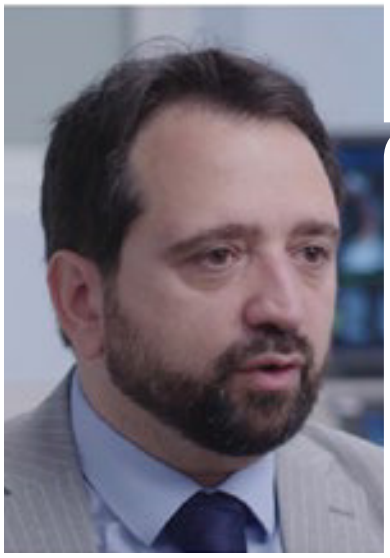
Getting the best view

While patients become larger and more difficult to scan and evidence-based reporting of ultrasound examinations is becoming increasingly important, the number and complexity of required measurements is rising, putting increasing pressure on the examiner.

New tools that employ Deep Learning were developed for Aplio, enabling the operator to automatically identify standard scan planes and to carry out routine measurements without any user interaction. This is particularly helpful in where the relevant guidelines require a wide range of measurements, such as in Cardiology and Women's Health.

"The biggest challenge we face in clinical routine is to perform examinations in crying children and across a wide range of patients ranging from fetuses to pre-term babies, children and up to adolescents with complex congenital disease," remarked Professor Giovanni Di Salvo, cardiologist at the University Hospital of Padua, Padova, Italy. "Aplio helps us a lot to meet these challenges because the current version is equipped with Artificial Intelligence. This makes the machine extremely helpful during the normal workflow because we can get accurate information in a fast way. For instance, the acquisition of volumes or ejection fraction by using biplane Simpson or global longitudinal strain with the current series of Aplio is extremely fast and extremely effective and, of course, accurate. This is very important because those measurements are now the standards required by the guidelines."

"Aplio also allows us to implement a lot of measurements into our daily routine that before were considered too complex and too time-consuming. Nowadays, we can implement them routinely in our practice, thanks to Artificial Intelligence. This makes a lot more measurements fast, accurate and reproducible," he added.



"Aplio also allows us to implement a lot of measurements into our daily routine that before were considered too complex and too time consuming."

Prof. Dr. Giovanni Di Salvo
University of Padua, Italy

New possibilities

Significant upgrades and the incorporation of AI to existing imaging and quantification technologies for fetal imaging into the new system has brought new and exciting possibilities for obstetricians.

"The new Aplio i-series Women's Health model is a fantastic system with very reliable B-mode, great imaging resolution, and very precise Doppler. The new SMI (Superb Micro-vascular Imaging) brings us very exciting perspectives when imaging the fetal heart at a later stage – something that was not possible before. Now, you can use it in the late second trimester and also in early third trimester. It also gives a lot of information on the venous return system," said Dr. Jader Cruz, fetal medicine specialist, Fetal Medicine Unit, Central University Hospital, Lisbon, Portugal.

"The new tool that I am most excited about is the introduction of Artificial Intelligence at a level that will be very helpful for education, training and even quality control of the images," he added. "It is very interesting, and I am very glad to be working with it. I have been very satisfied working with Aplio for the past years and have fully explored it. And now Canon brings new technologies that enable us to go and learn even more. It is very exciting."

Next generation ultrasound

Feedback from clinicians across the world indicates that the latest version of Aplio features technologies that enable significant improvements in the already outstanding image quality and clinical workflow truly representing a next-generation diagnostic ultrasound system. //

"The new tool that I am most excited about is the introduction of Artificial Intelligence at a level that will be very helpful for education, training and even quality control of the images."

Dr. Jader Cruz
University Hospital Lisbon, Portugal

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