visions

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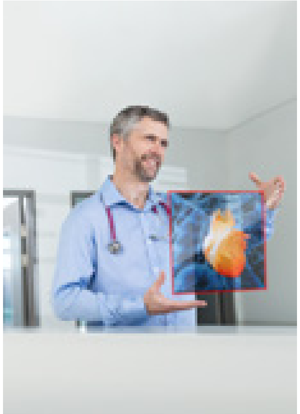

Image from Canon Medical's 'Made for Life' corporate campaign.
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Together, we make it possible.

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Folow us:

// EDITORIAL

There are various developments going on shaping our everyday life in the future, including the future of healthcare. Some are already discussed intensively and even show some initial results, others are just appearing upon the horizon. Examples are: AI (Artificial Intelligence), Big Data, Virtual and Augmented Reality, NanoTech, NeuroTech, as well as 3D and 4D printing. Regarding the latter, I have recently read some astonishing news about 'Project Milestone'; the world's first commercial housing project in Eindhoven, The Netherlands, which is based on 3D printing.[1]

Printing houses is a fascinating experiment, but the benefit of 3D printing in the medical domain mainly concerns things, such as planning of operations, the education of medical students and, probably best known, printing of prosthetics. As one can imagine, the quality of these prints strongly depends upon (ultra) high-resolution images captured by CT, MR, Ultrasound or X-Ray systems, post-processed by advanced visualisation software and exported in STL (stereolithography) format. A technology that can contribute to the quality of the captured images is, amongst others, Iterative reconstruction (AIDR 3D and/or FIRST), as it lowers the noise, particularly in pediatric or low-dose imaging.

With the above in mind you can ask yourself what the next step might be. What if we were able to print custom organs? Across the 47 Member States of the Council of Europe, 142,388 patients were waiting for a transplant in 2016[2]. That is the equivalent of the capacity of 286 airplanes (A380). From these, 41,544 were transplanted. Think about the capacity of the football stadiums of Helsinki, Turin or Minsk. The most commonly performed transplants are Kidney (63%), Liver (24%) and Heart (6%). Altogether, a great achievement, but this still leaves us with the huge challenge of preventing 19 patients from dying per day, waiting for an organ that never arrives.

Through pioneering technology and clinical research, we are continuously developing and improving our imaging systems and visualisation software to contribute to these promising directions. Using better images would enable better organs to be produced. At Canon Medical, we have an ongoing commitment to humanity. Generations of inherited commitment to medical innovation is creating a legacy and service that continues to evolve as we do. By engaging the brilliant minds of many, we continue to set the benchmark in our field, because we believe quality of life should be a given, not the exception.

Kind regards,

JACK HOOGENDOORN
Senior Marketing & Brand Manager
Canon Medical Systems Europe BV

Reference
[1] https://3dprintedhouse.nl
[2] EDQM - European Directorate for the Quality of Medicine & HealthCare

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Canon Medical Systems Corporation honored at 2018 Ceremony of National Commendation for Invention

This year (in May 2018) Canon Medical Systems Corporation received the Minister of Education, Culture, Sports, Science and Technology Award but also the Invention Achievement Award, at the Ceremony of National Commendation for Invention, hosted by Japan Institute of Invention and Innovation.

These awards were given in recognition of Canon Medical's proprietary technology of Differential Tissue Harmonic Imaging (D-THI).

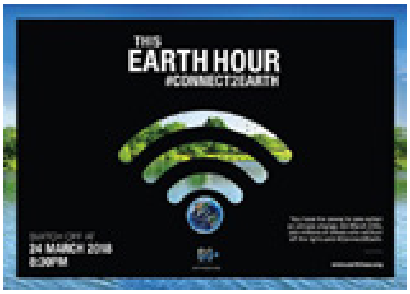
This function is based on "utilizing differential harmonics from two fundamental frequency components and their second harmonic in diagnostic ultrasound apparatus" (Japan Patent Office, No. 4557573). //

10 Facts About Samurai Warriors

https://youtu.be/TuwZNogSCmQ

Earth Hour 2018

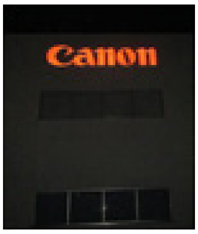
It was "lights off" for global Canon Group companies during the world-wide Environmental event "Earth Hour," held on March 24, 2018.

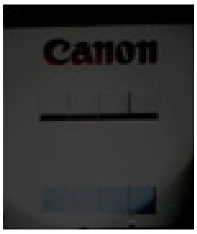


"Earth Hour" is a global environmental movement, started by the WWF in 2007, during which people share their desire to stop global warming and protect the global environment by turning off lights at a certain day and time (from 8:30pm to 9:30pm local time). Earth Hour 2018 took place across 188 countries and regions.

This year's lights-off activities at Canon Group companies around the world!
Canon fully supports the concept of Earth Hour and has held a global "lights-off event" across Canon Group companies around the world since 2016. Our event started in Oceania, which is closest to the International Date Line, and moved around the world to Asia, Europe and America.

This year a total of 323 Group Company offices and operating sites across 38 countries and regions participated in the event, with Canon Medical Systems Corporation participating as part of the Canon Group for the first time. //





Canon designs recognised with internationally renowned iF Design Awards for 24th consecutive year

Established in 1953, the iF Design Awards are recognised as one of the most prestigious awards within the field of design, with outstanding industrial designs chosen from all over the world.

This year, 6,402 entries from 54 countries and regions were judged by internationally renowned design experts across seven categories. These included product, packaging, communication, interior architecture, professional concept, service design/UX and architecture. This year marks Canon's 24th consecutive year of winning iF Design Awards. Encouraged by the recognition of the company's design excellence, Canon will continue striving to realise products that combine the highest levels of performance and design.

Winning products: iF Design Award 2018:

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New video game brings ancient craft techniques into modern life

The popular Japanese video game, Ukiyoe Heroes, brings together an ancient culture and an ancient art form into a modern format. This has been created through the extraordinary skill of two unique artists (David Bull and Jed Henry) based in Tokyo, Japan – One highly skilled in drawing and woodblock craftsmanship and the other in creating video games. With the success of the Ukiyoe Heroes game has led to the creation of a new game called 'Edo-Superstar'.

"For hundreds of years, Japanese woodblock printmakers worked in a thriving popular art scene. Their prints depicted heroes, villains and monsters, spanning every genre from satire, to romance, to horror. It was all part of Ukiyo, or 'Floating World' culture," explained David. "Inventive and fast-paced, Ukiyo culture was the big movement of its day. That tradition has continued through the centuries, down to the modern day, where Japan is still known for its vibrant creativity."

"Not only are we making fun, meaningful art. We're also working to save the Japanese woodblock community in a very real way," said Jed. "Through print sales, Dave has a workshop full of apprentices, and even employs seasoned masters in the craft. Our goal is to pump vitality back into this art form, by giving it modern appeal, while maintaining its ancient traditions."

https://ukiyoeheroes.com
YouTube videos;
search on 'Art of the game: Ukiyo-e Heroes Documentary Trailer' and/or 'Ukiyoe Heroes (18): Making 'Infestation' //

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To our valued customers, we would like to express our gratitude for your continued support in using our products and services.

On April 2, we welcomed a total of 145 new recruits. They are the first to enter the company under our new name, "Canon Medical Systems Corporation". Each of these new recruits understands and is fully committed to our company philosophy, "Made for Life", and they enter the company with the sincere intention to contribute to healthcare.

We expect that over the next 10 years, 20 years, or longer, they will accumulate specialized knowledge and grow as vital human resources to support Canon's healthcare business.

Reviewing the current business environment, this year the medical reimbursement system has been revised, which occurs every two years in Japan. The main focus of this revision was to establish a high-quality and efficient healthcare delivery system, taking into account that in 2025 the baby-boomer generation will reach the age of 75.

The front line of medical care across the world also requires highly efficient systems, which can integrate the increasing volume of healthcare information and assist medical professionals in providing a high-quality service to their patients.

The healthcare environment is undergoing rapid changes, with aging societies in many countries, shifting disease prevalence patterns, and increasing medical costs. In order to meet these global challenges by providing optimal solutions, Canon Medical Systems must adapt, evolve, and move forward quicker than ever before.

TOSHIO TAKIGUCHI
President and Chief Executive Officer
Canon Medical Systems Corporation


MAVIG

On the photo:
Dr. Namdar, MD, PhD
Assistant Head Physician;
Cardiology/Electrophysiology

Canon Medical's Infinix-i Biplane -

A State-of-the-art investment for the University Hospital Geneva

Mrs. Florence Savoye, Prof. Dipen Shah

As part of its aim to enhance its capacities in the Interventional Cardiology electrophysiology research field in Europe, the University Hospital Geneva (HUG) has invested heavily in the exceptional new Infinix-i Biplane system from Canon Medical. The new system enables both simple and complex interventions to be carried out in clinical practice. With the complicated redesign and installation process almost complete, the hospital has already started to benefit from this state-of-the-art investment.

New Interventional Cardiology suite

Headed by Mr. Herve Jacquemoud, the Biomedical Engineering Department at the HUG has five engineers and one assistant engineer. The team is dedicated to provide the highest possible standards of clinical interventional care, including emergency situations. In addition to this, they aim to achieve optimal efficiency and create a pleasant clinical environment to work in.

Through exceptional planning and coordination, the team have led the procurement of new equipment for many facilities, including three brand new cathlabs, which have recently been completely redesigned and refurbished over the last two years with state-of-the-art equipment from Canon Medical. HUG is the first hospital in Switzerland to acquire the new Infinix™-i Biplane system for one of these specialist rooms.

"Our mission was to create fantastic rooms for our clinical teams according to three principal objectives: Improved ergonomics and accessibility for patients; improved or maintained exceptional image quality; and decreased dose received by patients and health professionals," said Mrs. Florence Savoye, Biomedical Engineer at HUG. "We first analyzed the current and future radiology and cardiology needs of the hospital in great depth towards meeting them in the design of new facilities, before we initiated the normal tender process for equipping them."

One of the Infinix-i Biplane's at the University Hospital Geneva.

Infinix-i Biplane

"To improve ergonomics, the Canon Medical system that we chose featured ceiling-mounted arms for the Anesthetists and Cardio-Technicians, alongside video management and even ultrasound systems," Florence Savoye continued. "With some additional devices featured in this specific design, installation of the system required rigorous coordination between the technical teams of Canon Medical and the HUG, to enable accurate integration between the systems and within the rooms and optimize flow."

Canon Medical has offered exceptional support to the HUG in the development of these complete and complex rooms, which is highly valued by the Hospital.

New clinical possibilities

While the advanced new imaging system from Canon Medical brings brand new options in Interventional Radiology and Interventional Cardiology, exceptional collaboration and team work of the clinical staff is still required to carry out these interventions. The clinical team at the Hospital include Prof. Dipen Shah, who is Director of the Cardiac Electrophysiology Unit, and Prof. Marco Roffi.

Prof. Shah explained how the Infinix-i Biplane is already enabling advances in Interventional Cardiology techniques, not just for the HUG itself, but also on a European level.

Prof. Dipen Shah.

"The new system clearly improved our technological capacity, provides multiple viewing options and better head access, as well as significantly reducing radiation exposure."

Mrs. Florence Savoye.

"We chose the Infinix-i Biplane based upon the excellent ergonomics of the system and the organizational aspects, operation, training and support from Canon Medical."

"Dose reduction in all cardiovascular procedures is particularly important for medical personnel and patients. Being able to achieve the magnitude of dose reduction that is possible with the Infinix-i Biplane, while preserving, or even enhancing our imaging capabilities, is very gratifying," explained Prof. Shah. "With the new system, we are able to perform simple and complex interventions, including advanced ablation techniques; diagnose and treat persistent and long-standing persistent atrial fibrillation (AF); atypical flutter; endocardial-epicardial ablation for ventricular tachychardia; complex atrial arrhythmias in adult congenital heart disease; and Premature Ventricular Contraction (PVC)-triggered idiopathic VF."

"The new Biplane system has clearly improved our technological capacity, as reflected in the significantly improved ergonomics of the system. It provides multiple viewing options and better head access, as well as significantly reducing radiation exposure," Prof. Shah continued. "Being able to position the lateral X-ray source on the opposite side has a beneficial impact on scatter radiation received by the operator. The real time dose tracking system also has clear benefits in reducing exposure for the patient."

Creating new standards in Interventional Cardiology

Several new protocols have been developed for use with the HUG's new Infinix-i Biplane system. Many of these have been inspired by the European Union's (EU's) Sentinel Project.

With the Infinix-i Biplane installed, the HUG has also been able to provide expert input into this project, which was created to develop many new European standards in Interventional Cardiology and Interventional Radiology. These new standards include: image quality criteria including performance assessment parameters for flat panel detectors; the design and contents of patient and staff dosimetry databases; and optimization strategies.

In addition, the Sentinel team have considered efficacy and safety in Interventional Radiology population screening, as well as sensitive groups such as pediatrics; the ethics of medico-legal issues in Interventional Cardiology and Radiology; and self-referral examinations. As well as setting standards for these issues, the Sentinel team have produced many training materials for clinical consultants on implementing these new protocols in clinical practice.

Extensive evaluations

Using the new Canon Medical system, The HUG Biomedical Engineering team worked with the physician Marta Sans-Merce to evaluated three radioscopy modes for the following dose measurements: "Low Dose", "Standard Dose" and "High Dose". For each speciality, and in partnership with the clinical team, they identified activity-specific protocols, in particular the "fluoroscopy" or "acquisition" modes, which involve image frame rate choices.

Prof. Shah at work.

From left to right: Frédéric Gaspoz (Canon Medical Systems Switzerland), Roelof Hoekstra (Canon Medical Systems Switzerland), Prof. Shah (HUG), Prof. Roffi (HUG).

"For each mode, a frame rate from 3 to 30 images per second was selected. Contrast and spatial resolution were selected as evaluation criteria to compare the image quality of the different installations. The dose was evaluated by means of incident kerma rate measurement, in mGy/s, at the time of examination," explained Florence Savoye. "We carried out more than 260 measurements to compare the Interventional Radiology systems as objectively as possible.

Using the 20*20 Infinix-i Biplane FPD in low dose radioscopy mode, an average reduction of 75% was observed with improved image quality. When using the "acquisition" mode (at a frame rate of 15 and/or 30 images), the dose could be reduced by 77% with an image quality that was slightly worse, but decent enough and sufficient for examinations. These observations have also been seen in the other modes and at different image rates. With further tests performed together with Canon Medical, the Spot Fluoro application showed a further dose reduction. Surprisingly, we noticed that several hospitals conducting similar tests during invitations to tender were interested in our results, which have also subsequently been published."

"The Infinix-i Biplane is a flexible, state-of-the-art solution for our Interventional Cardiology needs," said Prof. Shah. "We certainly hope to maintain and evolve our expertise with the edge provided by this impressive technology platform."

"The dose linked to image quality was certainly an important factor in deciding for the Infinix-i Biplane in our final selection, but it was not the only factor," said Mrs. Savoye. "We chose the best machine based upon the excellent ergonomics of the system and the organizational aspects, operation, training and support from Canon Medical. All of these scored points with our four main criteria, which are: technical, price, operation and clinical.

The Canon Medical team has been exceptional in understanding our specific requirements and in collaboration with HUG project. We will be equipping a third new room in late 2018 with an Infinix™-i Sky + system monoplane are counting on Canon Medical to help us complete this project, as well as they have done with the first two." //

University Hospital Geneva (HUG), Switzerland.

Dose reduction to breasts can be obtained using Organ Effective Modulation (OEM) in chest CT

Svea Deppe Mørup, Helle Precht

As a Radiographer, it takes knowledge and dedication to utilize the full potential of the CT scanner in daily work. For each patient scan, the radiographer will consider technical parameters based upon individual patients regarding anatomy, diagnostic focus, size and age-/radiation-sensitivity to support the CT scanner as a vital tool for diagnosis. The on-going technical developments from the companies, together with the availability of CT scanners have occurred rapidly and, in many cases, this has led to the replacement of conventional x-ray examinations. CT optimization requires continuous effort and close co-operation of the Radiographer, Physicist and Radiologist. Optimization can only be performed if the Radiographer acquires proper training regarding the dose levels, how the parameters affect the image quality and the available possibilities provided with new equipment and new software.

At University College Lillebelt, in Odense, Denmark, we educate Radiography students. To give the students the best education, we have a large 'skills- lab' for training. In the 'skills-lab', we are able to combine theory with practice, which gives the students a better understanding of the theory and how to implement it in practice. To strengthen student skills regarding CT and to keep up with on-going developments in CT, we replaced our old four-slice CT scanner with an Aquilion™ PRIME CT (Canon Medical) in 2016. The scanner is used for both research projects and training of the students in CT and radiation protection.

Within the last year, we have performed several different projects with Organ Effective Modulation (OEM). The purpose of this software is to minimize exposure to radio-sensitive organs, such as the breasts and eye lenses, by decreasing the tube current around the anterior of the body at an angle of 120 degrees (2).

Aim

The aim of this project is to assess the possibility of dose reduction and maintain image quality in a chest CT scan using OEM.

Methods and materials

Assessment of radiation dose

An anthropomorphic phantom (Multipurpose Chest phantom N1 Lungmann, Kyoto Kagaku, in Japan), with an attached custom-designed breast phantom were used. The breast phantoms were made with a combination of pig-fat and egg-whites together with gelatin measuring an HU of -56.54. They were cast into a model, in which each breast contained 574ml. (figure 1), which according to Anderson et al. (1) is the mean size of a Danish breast.

Thermo-luminescent Dosimeters (TLD) were place around the phantom. In total, eight tablets were placed for every scan (figure 2).

Figure 1: Lungmann with an attached custom-designed breast phantom.

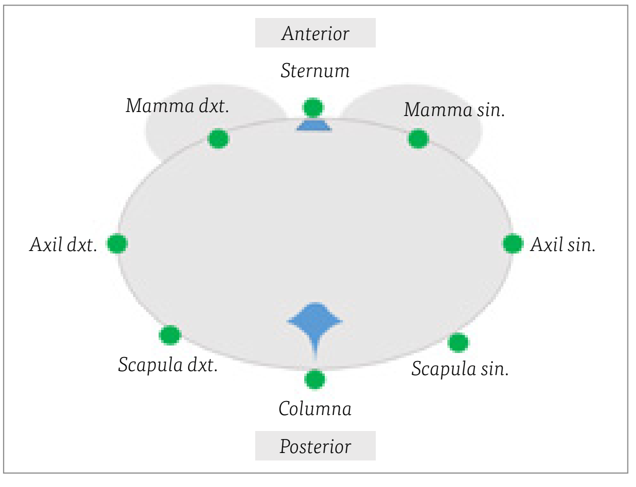

Figure 2: placements of TLD tablets.

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Figure 3: the locations of the noise measurements.

All scans were performed on a Canon Medical's Aquilion PRIME CT - scanner. A standard CT chest protocol with tube current modulation (SD 10) was used, with and without OEM, with the following kVp settings of 80, 100, 120 and 135kVp. All scans were performed with AIDR 3D Standard, a pitch of 0.813 and a rotation time of 0.35 s. All settings were repeated five times, to allow for unwanted variations from the generator or tube. After every scan, the $CTDI_{vol}$ and DLP were reported, and the TLD's were changed.

Assessment of image quality

For the image quality assessment, nine different tumors were placed inside the phantom. The tumors were placed around the whole thorax and had different sizes (3mm x 5mm, 3mm x 8mm, 3.12mm) and Hounsfield Units (3 X 100HU, 3 X -630, 3 X -800HU).

To assess the subjective image quality, a visual grading analysis (VGA) (Zarb et al., 2014) was performed. One observer with five years of experience of reporting chest-CT made the VGA. The observer was presented with one CT examination at a time. The images were presented using ViewDex, in which the images were displayed on a diagnostic monitor and scored electronically (4-6). The observer scored each CT examination according to predefined VGA image criteria (table 1) and on a five-point scale for criteria 1-4 (table 2). For VGA, criteria 5, a number between 1-9 could be chosen and for criterion 6 the observer could use not approved or approved. The diagnostic monitor was tested according to the official recommendations. All images were randomized and blinded with respect to the exposure settings, dose levels and reconstruction method.

Technical image quality criteria were also evaluated by the researchers in blinded fashion. Noise was measured by standard deviation (SD) of CT numbers in five circular ROIs placed in the breast, heart, vertebral body, trachea and outside the phantom, respectively, as shown in figure 3.

Results

Assessment of radiation dose

To assess the radiation dose measured by the TLD tablets, the background dose was subtracted from all the tablets that were scanned. The total dose was calculated from all five CT scans at every kVp level. The result from the TLD tablets showed that when applying OEM, the dose to the breast region decreased, see Table 3. For 80kVp the radiation dose decreased by 6.04mSv, for 100kVp

VGA score	VGA image criteria
1	Visually sharp reproduction of the trachea and main bronchi
2	Visually sharp reproduction of the large and medium-sized pulmonary vessels
3	Visually sharp reproduction of the lung parenchyma
4	The degree of detail of the pathology?
5	How many tumours are visualized
6	Is the examination approved for diagnostic use?

Table 1: VGA image criteria.

VGA score	VGA rating scale
1	Poor image quality: image not usable, loss of information
2	Restricted image quality: relevant limitations for clinical use, clear loss of information
3	Sufficient image quality: moderate limitations for clinical use, no substantial loss of information
4	Good image quality: minimal limitations for clinical use
5	Excellent image quality, no limitations for clinical use

Table 2: VGA rating scale used by the observers.

kVp setting	Total radiation dose
80kVp without OEM	93.99mSv
80kVp with OEM	87.95mSv
100kVp without OEM	86.92mSv
100kVp with OEM	82.75mSv
120kVp without OEM	96.57mSv
120kVp with OEM	91.90mSv
135kVp without OEM	49.25mSv
135kVp with OEM	46.56mSv

Table 3: dose from all settings.

the dose decreased by 4mSv, at 120kVp a reduction of 4.67mSv was achieved. For 135kV the dose reduction was 2.69mSv. The dose distribution around the phantom is shown in figure 4 for 120kVp with and without OEM.

Assessment of image quality

The subjective assessment of the image quality (VGA) was analyzed by performing visual grading characteristic (VGC) curves. All VGC points were plotted to produce a VGC curve and to calculate the "area under the curve (AUC_VGC)" (3-4). The result showed that for 80 kV the AUC_VGC was 0.5, which indicate that the image quality is equal to with and without OEM.

For 100kV, 120kV and 135kV the AUC_VGC was 0.56, 0.62 and 0.62 indicating that the scans performed without OEM is slightly better than the scans performed with OEM. All scans were approved for diagnostic use by all observers. The observers did not detect all tumours that were placed inside the phantom for all settings. The largest amounts of tumours were detected for 120kVp, 8 without OEM and 7 with OEM.

The technical noise measurements were calculated through an average from all five scans. The measurements showed a minimum increase in objective noise when applying OEM. For 80kVp the SD increased by 3.61, for 100kVp by 2.7, at 120kVp the SD changed by 1.1 and for 135kVp the SD increased by 3.99.

Discussion

In this study, we investigated the effect of OEM for chest CT. The data showed that it is possible to decrease the radiation exposure to the breast region and with only a fair amount in noise increase.

The dose reduction varied from 6.04mSv at 80 kVp to 2.69mSv at 135 kVp using OEM, given increase in noise going from 3.6 to 3.99, respectively. The standard setting for most CT chest protocols is 120 kVp, which gave a reduction of 4.67mSv and the smallest increase in noise, that will slightly affect the image quality. This is also confirmed in the VGA, as the observers detected most tumors at 120 kVp. The smallest number of tumors were detected at 80kVp, this can be explained by the linear co-efficient that changes the HU when the kV is changed.

This study showed that the dose- saving is not as large as suggested in other papers (2), the reason for this variation is that in our study tube current modulation was already applied, which gives a decrease in radiation dose compared to other studies that have used a fixed mA as a starting point. The dose did not increase at any of the settings behind the phantom.

Conclusion

It is possible to apply OEM for chest-CT scans and obtain a dose reduction to the breast with only a small increase in objective noise. //

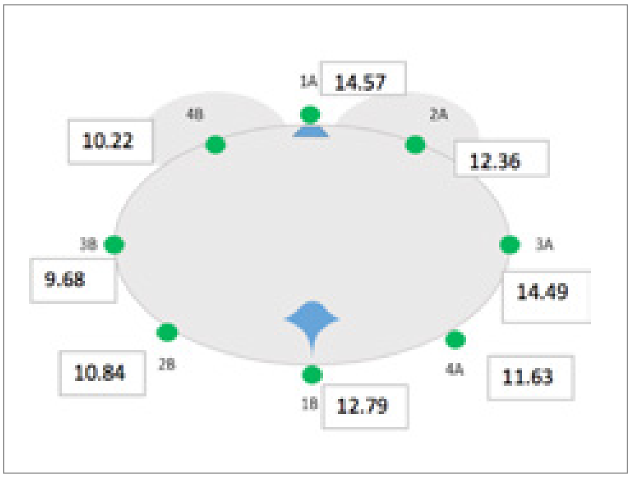


Figure 4a: shows the measured radiation dose without OEM in mSv.

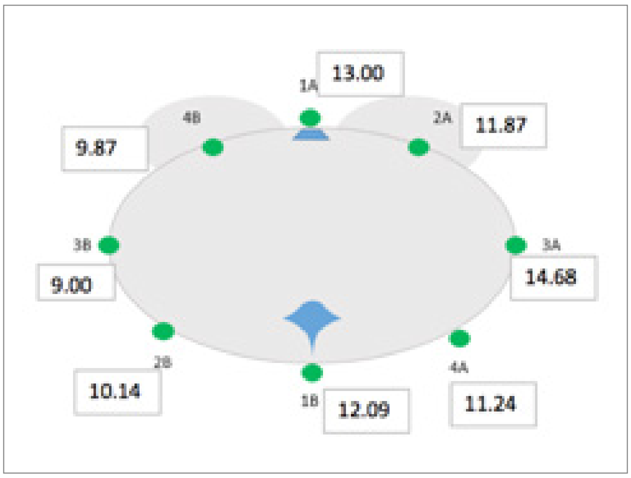
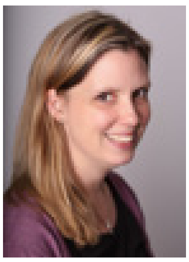


Figure 4b: shows the measured radiation dose with OEM in mSv.



Svea Deppe Mørup,
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Aging Imageomics Study: Looking at imaging, seeing health

Josep Puig, MD, PhD

The greatest demographic transformation in the history of humanity has taken place within the last 100 years. Improved survival has made it possible for the population to grow despite low birth rates. Increased life-expectancy is partly due to improved living conditions and healthcare, but the greatest impact is from government policies that promote health and primary prevention of disease. Indeed, to prevent disease, it is fundamental to focus on potential health risks for the population. To foster good health in the entire community, authorities need large volumes of reliable, accurate and comparable data about the impact of different risk factors. Health promotion and primary prevention are the most effective strategies to reduce morbidity and mortality and to delay the onset of chronic diseases associated with aging. Generally speaking, these strategies are based on the knowledge that many diseases develop over decades and that this process involves a long asymptomatic period during which specific actions can change the course of the disease.

Nowadays, the intensity of health promotion and primary prevention interventions is determined by classifying the risk of disease using different predictive models based on biomarkers. There are several of these models for classifying cardiovascular risk for example, such as the Framingham Risk Score – mainly used in the US, the Systemic Coronary Risk Evaluation (SCORE) in Europe, or the Registre Gironí del Cor (ReGiCor) in the province of Girona.

Nevertheless, these models may not be sufficiently accurate at classifying cardiometabolic risks; their shortcomings derive from the complex interaction of many components in the long period of "silent", subclinical development of most diseases.

First, these algorithms are based on very prevalent risk factors, and this weakens their predictive power. Moreover, they do not take into account markers related to biopsychosocial factors, lifestyle, family history, vascular status, insulin-resistance, physical inactivity or obesity.

Finally, many of the alterations in tissues occur gradually without causing symptoms in populations that are considered low risk. It is important to note that in some diseases, no symptoms are evident even after the disease has advanced considerably. These limitations underline the need for new noninvasive biomarkers that would enable the risk of disease to be classified and monitored earlier and more accurately.

Figure 1: The mobile MRI scanner, Vantage Elan

MRI is accurate and reproducible; its versatility and ability to characterize organs and tissue is outstanding, including the detection of early changes in the human body that would be imperceptible with other techniques. Whole-body MRI is an efficient way to scan the entire human organism, allowing to extract precise information from targeted organs; it could be a useful tool for assessing asymptomatic individuals because of its high sensitivity and specificity in detecting morphological and functional alterations without inducing harmful effects.

MRI biomarkers like those proposed in the project described below could be used to identify subclinical diseases and quantify the burden of morbidity from the different biopsychosocial risk factors. Over the past two decades, imaging has increasingly been implemented in population-based cohorts to

Figure 2: The mobile MRI scanner.

obtain information on the assessment of subclinical disease burden, allowing for a more comprehensive assessment of development of disease states. This has resulted in improved understanding of complex disease processes, as well as identification of novel imaging biomarkers as a precursor for overt disease states.

'Aging Imageomics Study' is a prospective, longitudinal, observational study for the evaluation of the brain, vascular system, heart, liver, fat tissue and musculoskeletal system with 1.033 individuals aged 50 years and older by multimodal whole-body MRI, already scanned. This project is developed by a large multidisciplinary research team and financed by the Government of Catalonia (Strategic Plan for Health Research and Innovation, PERIS 2016-2020). The subjects are the participants in the Madurez y Envejecimiento Saludable en Girona (MESGI50) study, whose objective is to compare the biologic, psychological and socioeconomic characteristics of the population aged 50 years and older in function of whether they live in a rural or urban setting in a representative sample from the province of Girona.

The MESGI50 study uses the "Survey of Health, Aging and Retirement in Europe" (SHARE) project's field methodology and questionnaire, which include valid and reliable measures of various items – health-related (physical, emotional and cognitive health, use of healthcare resources), psychological (well-being, life satisfaction, beliefs), economic (line of work, retirement, savings, consumption), and social (social support, social and family network, intergenerational transfers). The ambitious objective of the 'Aging Imageomics Study' is to know more about the overall health of the population in order to improve it.

In biomedicine, terms ending in –omics refer to disciplines, technologies or research areas that encompass the totality of a biological system. The suffix –omics is added to a term to define a biological system, understood as an entire organism or a functional part of it. The –omics are important as disciplines in and of themselves, but also as new knowledge-based tools that allow to go deeper into more specific fields. The present project makes it possible to access a huge dataset of quantitative and qualitative imaging data of the human body from the age of 50 years; for this reason, the research team has coined the term 'Aging Imageomics'.

In addition to correlating all the parameters related to the biopsychosocial and cardiometabolic profiles, this project will also determine the relationship between data from whole-body MRI and metabolomics (set of science and techniques for investigating the metabolic system at the molecular level) and gut microbiome (set of microorganisms normally found in the digestive tract). One of the challenges of this research is to integrate all this information in an individualized way to reach a better understanding of the physiological processes of the human body and to help describe the organism as a whole. The repository of MRI studies will help us to better understand the physiological processes associated with aging in the human body, as well as to model the aging of organs through a metabolic, structural and functional imaging atlas.

All this information will be useful in developing advanced imaging biomarkers to identify biopsychosocial risks associated with aging and in generating new hypotheses for further studies. Identifying risk factors for health problems through advanced imaging biomarkers based on whole-body MRI could be a tool for stratifying subjects in the population who could benefit most from primary prevention. The project will allow us to determine the normal values for each of the many variables derived from the advanced whole-body MRI protocol.

All MRI examinations were done on a mobile 1.5T scanner (Vantage Elan™, Canon Medical Systems) installed in a truck (Figure 1), using a head coil and two body coils to cover the entire body, with a maximum gradient amplitude of 33mT/m. The acquisition protocol includes coronal T2-weighted short-tau inversion recovery (STIR) sequences of the whole body, sagittal T2-weighted fast spin-echo (FSE), short-axis 3D steady-state free precession (SSFP) sequences of the myocardium, 2D phase-contrast magnetic resonance angiography (MRA) of the aortic arch, coronal 2p Dixon method from the liver to the symphysis pubis, and diffusion tensor

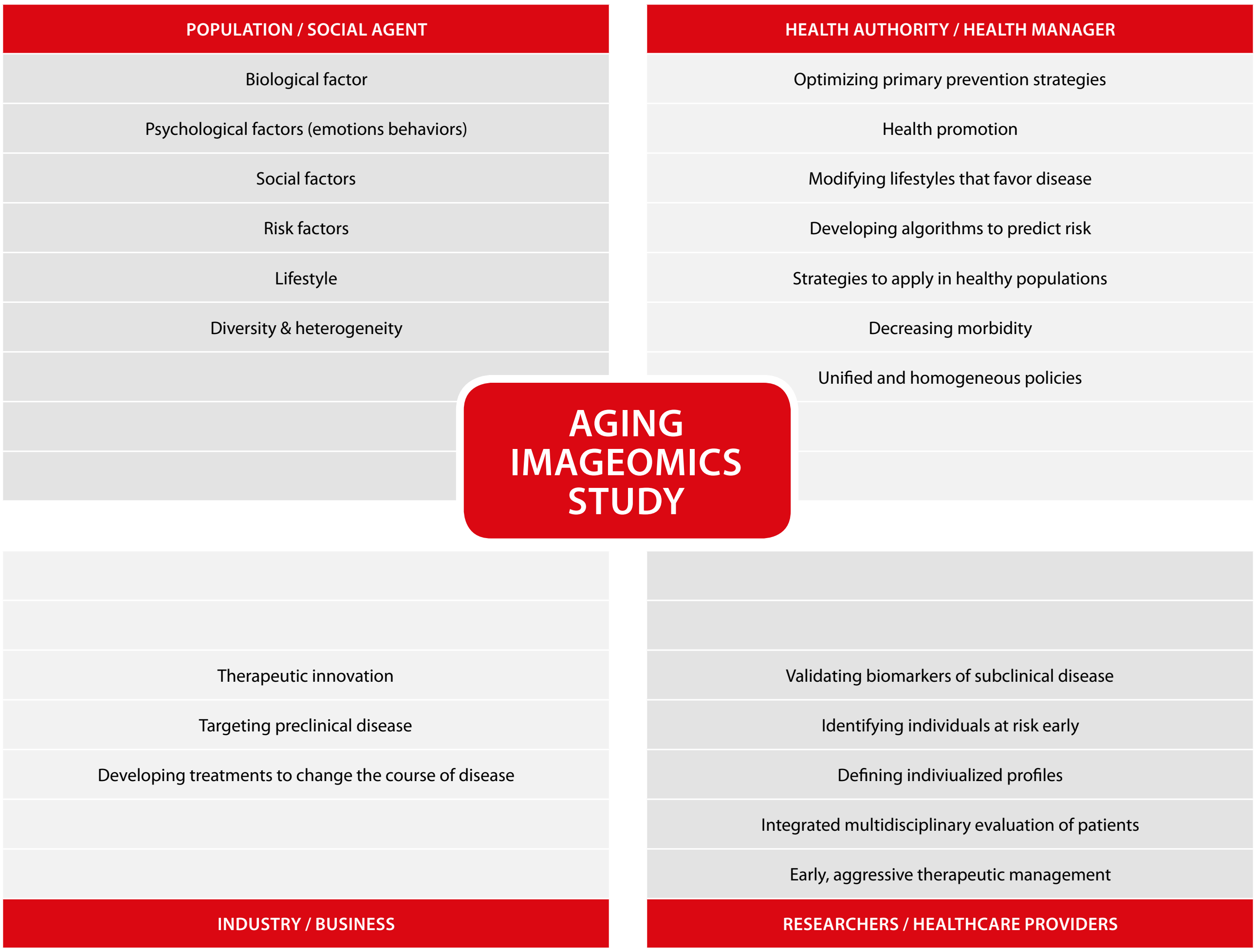

Figure 3, Why the 'Aging Imageomics Study' is interesting for society.

techniques, resting-state fMRI, R2* mapping, high resolution 3D T1-weighted and T2-weighted FLAIR sequences of the central nervous system.

An estimation of the morbidity load derived from the various risk factors were included, each of which can be modified by many different strategies; this will enable to obtain an overview of the relative role of the different risks for the health of the population as well as of individuals. Along these lines, in the future, imaging biomarkers based on whole-body MRI could be validated as tools to assess personalized risk, making it possible to reliably estimate and compare the morbidity load associated with one or more risk factors. The large amount of quantitative data available can make imaging biomarkers based on whole-body MRI useful for monitoring the effects of future primary prevention strategies. Finding a lesion in an asymptomatic patient results in more treatment options, better prognosis and lower treatment costs than finding the same lesion in later stages of disease.

The impact and influence of the project will be important, as the results will be useful for the population, health authorities, public health officials, health researchers, health providers and health-related companies and industry (Figure 3), whose managers need solid tools to assess overall community health and apply plans and direct financial resources.

'Aging Imageomics Study' will enable to identify biomarkers of the risk of becoming ill and thus to stratify the population so that primary prevention strategies can be optimized with the final aim of reducing morbidity and mortality in the population. //

Josep Puig, MD, PhD
Coordinator, Research Unit at Institute of Diagnostic Imaging (IDI) in Barcelona, Spain; Girona Biomedical Research Institute (IDIBGI), Medical Imaging Group; Department of Radiology, University Hospital Dr Josep Trueta, Girona, Spain; Associate Professor at the Faculty of Medicine, University of Girona, Spain.

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VISIONS spoke with Dr. Luc Steyaert about Aplio i800.

Premium Ultrasound enables new possibilities in Diagnostic and Interventional Radiology

Sint-Jan Brugge-Oostende AV Hospital has purchased six premium Aplio i800 ultrasound systems from Canon Medial to meet the increasing demand for ultrasound in Diagnostic and Interventional Radiology. There has been a 25% increase in certain types of ultrasound examinations at the Hospital, including many more complex diagnostic and interventional procedures. About ten ultrasound-guided interventional Radiology procedures are carried out per day. Much more is possible for the radiologists with this state-of-the-art ultrasound system.

Dr. Luc Steyaert is recognized as one of the most experienced leading European clinical experts in ultrasound diagnostics imaging. He has been a clinical advisor on new developments in the ultrasound industry for many years and has also been key in supporting and advising Canon Medical's ultrasound R&D over the last decades.

"Our extensive new Endoscopy and ultrasound unit, which has been completely redesigned over the past few years with the latest Canon technology enables the dedicated team to diagnose far more conditions and develop new techniques in Interventional Radiology (IR)."

Enhanced capacity

"The purchase of the Aplio™ i800 ultrasound systems was a future-oriented investment that brings patient-friendly, harmless, and affordable, high-quality diagnostics, and more direct involvement for the consultant. The radiology suite has expanded in staff numbers with a much bigger ultrasound team now.

Increasing demand has triggered rebuilding and expanding the ultrasound department to seven ultrasound rooms, two mammography suites, and one mammography interventional room that supports an increasing number of ultrasound guided interventions.

More specific training for assisting personal, with a dedicated group, such as CT or MRI With improvement of image quality and ultrasound possibilities lead to greater increase of ultrasound exams. More complex diagnostic and interventional procedures are possible. Clinicians trust in the diagnostic performance of the new Aplio i800 system.

Dr. Luc Steyaert.

Quality brings new possibilities

"The image quality of the Aplio i800 is extremely good," said Dr. Steyaert. "This system fits well into our strategy of affordable innovative, reference care for everyone. It can adeptly handle all our high-end ultrasound imaging applications.

"A quantum leap in image quality and overall performance of the Aplio i-series."

Benefits of the Aplio i800

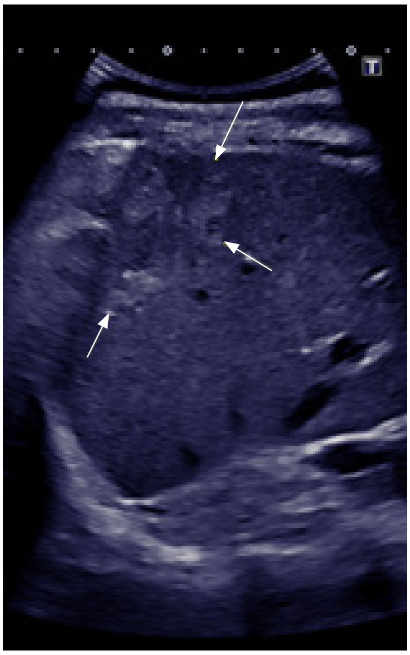
The Aplio i800 offers high-quality standards in ultrasound imaging. It has been welcomed by the radiologists as a powerful diagnostic (and therapeutic) problem-solving tool that can be used with optimal reliability and fast diagnostic accuracy, 24/7. This new ultrasound system has raised some interesting development points for the Hospital.

The advanced techniques that are possible with this ultrasound system have encouraged the Radiology Team to invest in developing a 'school of ultrasound' with experienced teachers and regular teaching courses in different aspects of ultrasound including musculoskeletal specialties. The department aims to work on patient awareness: so that patients realize that radiologists are important in the whole medical process. Young radiologists must realize that ultrasound is a very important part of medical imaging with a great future: they should not be 'blinded' only by MRI or hi-speed CT. There is a growing interest in the radioprotection possibilities of ultrasound exams. //

Case 1:
39y old female patient

Routine abdominal ultrasound in a patient with chronic urticaria and history of auto-immune thyroid disease.

- *US: detection of a solitary liver lesion, inhomogeneous texture, no real mass effect.*
- *CEUS (contrast enhanced ultrasound) -Sonovue.*
- *CEUS with SMI**.*



US: detection of a solitary liver lesion, inhomogeneous texture, no real mass effect.

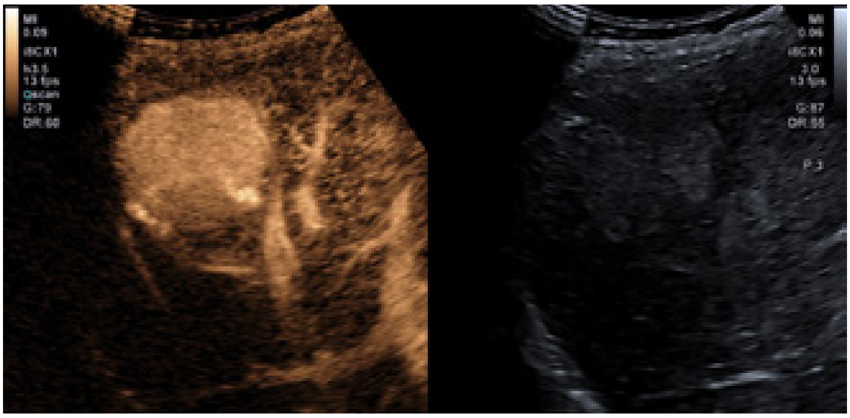


Image after 20 sec.: earlier and more intense enhancement than normal liver parenchyma.

CEUS with reference image. Low mechanical index (MI 0,06 >< 1,2 for standard US image).

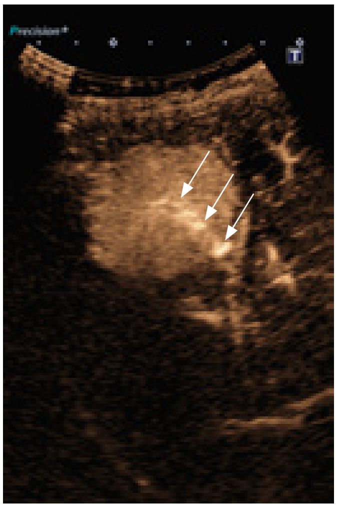


Image 17 sec. after injection: demonstration of feeding vessel.

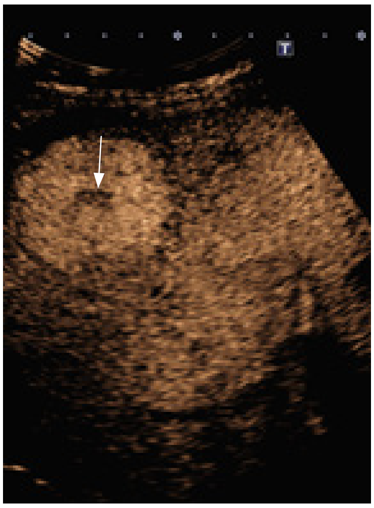


Image 4 min. after injection: persisting higher enhancement than normal liver parechyma demonstration of central scar with lower enhancement.

SMI with low MI (0,05). Demonstration in real time (47 frames per second) of typical spoke whell vascular pattern characteristic for FNH. Normal color Doppler requires high MI of 1,6, which would destroy contrast bubbles.

Conclusion case 1:

- *Ultrasound is capable of detecting and characterising liver lesion (FNH-focal nodular hyperplasia) with certainty in only 4 minutes.*
- *Diagnostic clues: morphology in B-mode, enhancement pattern and morpholgy of vascular pattern.*
- *3 phase CT or multi-sequence MRI is obsolete.*

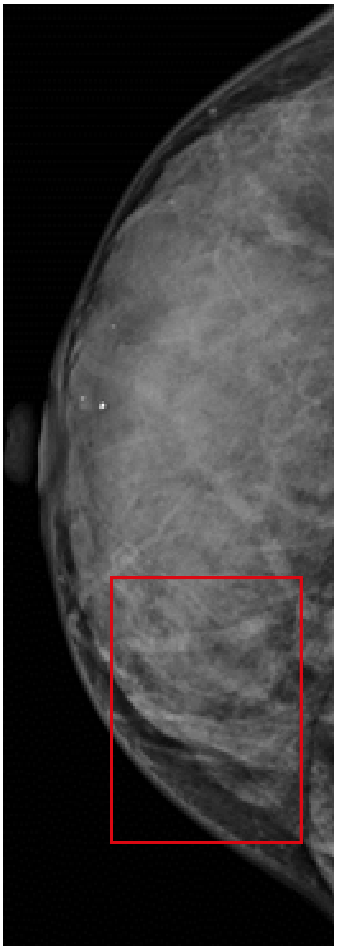
**Superb Microvascular Imaging (SMI): a novel ultra-high sensitive fast Doppler Imaging technique to visualize microvascular flow.*

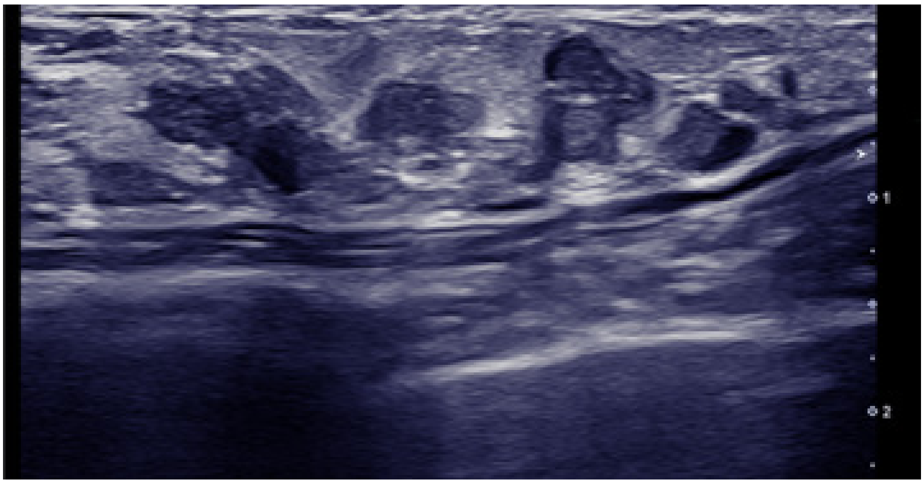
Case 2:
44y old patient

Patient was feeling a slight induration medially in the left breast.
Gynecologist performed clinical examination and concluded that it was only dense glandular tissue.
Further examinantion was denied because of clinical result and age (falling out of screening age group (50-69).

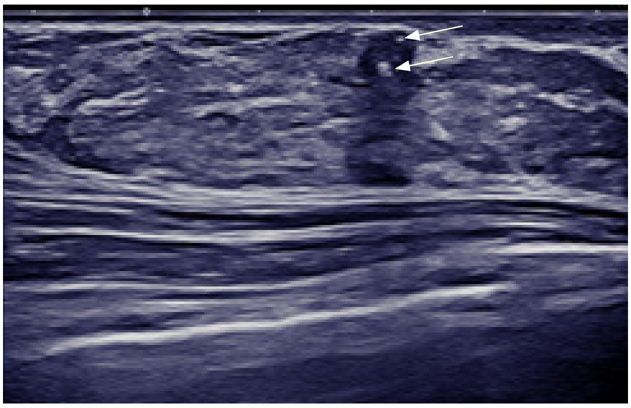
Second opinion in our institution:
- Mammography showed very dense tissue (BiRads classification D).
- Ultrasound was performed because of very low sensitivity of mammogram.

US findings:
- 2,2cm long abnormal hypo-echoic area in the breast.
- Ultra-High frequency US (24MHz transducer) showed areas with microcalcifications.
- SMI shows increased vascularity in the abnormal zones.
- Diagnostic vacuum assisted large core (8G) biopsy was performed in the abnormal areas.

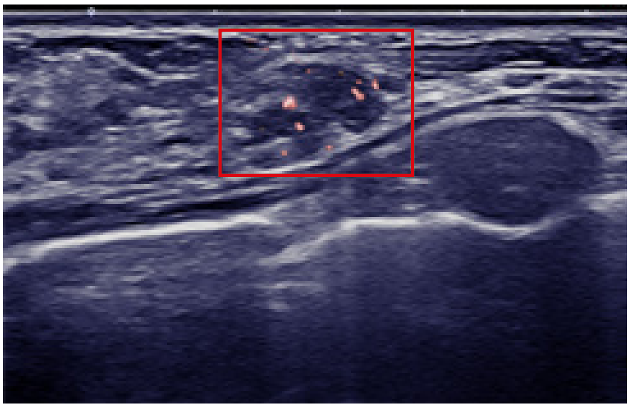




Area of the US abnormalities.



Typical hypo-echoic tumoral area with central microcalcifications: typical US image of DCIS with comedonecrosis.



Hypo-echoic tumoral area with increased vascularity on SMI.

Conclusion case 2:

- High frequency US outperformes mammography in detection and characterisation of lesions, certainly in dense breast.
- US is a mandatory complementary exam to mammography, increasing sensitivity and specificity.
- US is the ideal guiding method for biopsy.

In this case, patholoic examination showed a complex pathology, consisting of:
- ADH (atypical ductal hyperplasia)
- Papillomatosis.
- DCIS grade 2 and 3, with comedo necrosis calcifications.
- 3 areas of invasive ductal carcinoma (2, 2,5 an 3mm). //

Dr. Luc Steyaert
Currently a full time staff member at the Radiology Department of St. Jan Bruges Hospital. Dr. Steyaert is responsible for ultrasound and breast imaging, and ultrasound interventions. He studied Medicine at Ghent University and trained as a Radiologist at the St. Jan Bruges Hospital, became a part-time consultant at the University of Brussels (VUB) for four years, and at Leuven University (KUL) for three years.

AZ Sint-Jan Brugge-Oostende AV

AZ Sint-Jan Brugge-Oostende AV is a health facility (for basic services and specialized care) with eight centuries of history and experience.

With 1,182 beds, the AZ Sint-Jan Brugge-Oostende AV is spread over three campuses: Sint-Jan and Sint-Franciscus Xaverius in Bruges and the Henri Serruys in Ostend.

They are known for their personal approach, professional developments, and their mutual cooperation.

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VISIONS spoke with Dr. Hans Orlent about his experiences with the Ultimax-i.

Creating new combinations in Endoscopy and X-ray

AZ Sint-Jan Brugge-Oostende AV is a combined health facility serving patients in Bruges, Belgium, with a growing expertise in innovative care for diagnosis and treatment of stomach, intestine and liver diseases. Endoscopy and X-ray are key in this. To achieve a better level of care and support new techniques, the Hospital needed to replace its endoscopy facilities. It turned to Canon Medical for an innovative and integrated solution. Dr. Hans Orlent, Head of the Department of Gastroenterology and Hepatology, described a little about his experiences in the development, installation and use of the new facilities.

"Our mission is to achieve good care for chronic and acutely ill patients with both common and rare pathological gastro-intestinal conditions. Until recently, we achieved this through the Endoscopy Unit that was built as an original part of the Hospital, but this became visibly aged," said Dr. Orlent.

"Our own X-ray equipment became unusable, and we had to utilize facilities from the Radiology Department for our research. This created an extra burden on the existing Radiology- and Anesthetics Departments and drove the need to develop new facilities."

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Canon Medical's Ultimax-i at AZ Sint-Jan Brugge-Oostende AV.

The Team.

Heading up a new unit

When Dr. Orlent was appointed Head of the Department of Gastroenterology and Hepatology, his priority was to develop a new endoscopy facility with centralized disinfection unit.

"With market developments at the time, which were led by Canon Medical, it became possible to purchase an endoscopy unit with its own integrated X-ray system. It was necessary to invest a lot of attention in the detailed design of the facilities."

Several companies and installed systems in other hospitals were consulted by the gastroenterology team research to find the right equipment offer. The Ultimax™-i system of Canon Medical appeared to have one of the largest detector widths, as well as excellent image quality. The positioning of the examination table in the Ultimax-i system allows spacious movement around the table. The table can be completely lowered to facilitate easy transfer of patients, onto and off the surface. The mobile C-Arm can also be maneuvered sideways.

Seamless integration

"With this system, we became convinced of the possibilities to achieve a high image quality, even with a low radiation dose," said Dr. Orlent. "We created a spacious feeling with installation of the equipment in the newly designed room. Optimal freedom of movement around the system enables our nurses and the anesthetics team to carry out their jobs and also maneuver equipment, such as breathing apparatus and oxygen supply. The examination table must also be sufficiently wide enough.

Dr. Hans Orlent.

"The Ultimax-i system has one of the largest detector widths, as well as excellent image quality."

The Team.

The integration of the Ultimax-i with the PACS server and new electronic patient dossier was achieved seamlessly with the technicians from Canon Medical. Their technical support and guidance was delivered in a friendly way with plenty of clear and useful instruction."

"The C-arm permits the region of interest to be observed from various angles," he continued. "In addition, the combination of a 43cm × 43cm flat panel detector (FPD) provides a large image field for a wide variety of examinations.

The new imaging technology 'Super Noise Reduction Filter (SNRF)' has been adopted to improve visualization in fluoroscopy, which is of critical importance in many examinations.

This system makes it possible to perform multidirectional imaging with a large image field and excellent image quality."

Advanced functionality

With the new endoscopy suite, the GI Team is able to use advanced techniques, such as endoscopic retrograde cholangiopancreotopography (ERCP), cholangioscopy, echo-endoscopy, endoscopic stenting, enteroscopy, radio-frequent ablations of esophageal Barretts' high grade dysplasia and carcinoma, and functional research.

"In implementing these advanced techniques that have been made possible with the new Ultimax-i system, we have adjusted some organizational regulations", explained Dr. Orlent. "However, we are now also able to explore brand new techniques – We are currently working on developing a new direct cholangioscopy method." //

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Ultra-High Resolution head subtraction CT Angiography in clinical practice

Dr. Frederick Meijer, Dr. Ewoud Smit

The Radboud university medical center, in Nijmegen, the Netherlands, installed an Ultra High Resolution Aquilion Precision CT scanner from Canon Medical last year. The Radiology team have already completed research in subtraction techniques in angiography using this system. The principle researchers include Dr. Frederick Meijer, Neuroradiologist, and Dr. Ewoud Smit, Resident in Radiology.

"The Ultra High Resolution Aquilion Precision™ CT scanner (UHR CT) has been used in clinical practice at our hospital since October 2017. It is integrated into our routine workflow for the whole range of CT applications, including diagnostic imaging of the head and neck," explained Dr. Meijer. "Non-contrast head CT scans on Aquilion Precision are scanned in normal resolution mode (with collimation 0.5 mm, matrix size 512mm x 512mm), with diagnostic image quality equivalent to the other CT scanners in our department - the Aquilion ONE™ ViSION Edition and Aquilion ONE™ GENESIS Edition CT systems from Canon Medical. In UHR mode, the collimation for the Aquilion Precision is 0.25mm and the scan is reconstructed with a matrix of 1024mm x 1024mm to reduce pixel size."

Routine subtraction scanning

"We are impressed that the radiation dose of CTA in UHR mode has proved to be comparable to CTA on conventional CT scanners,

Dr. Ewoud Smit, Resident in Radiology, and Dr. Frederick Meijer, Neuroradiologist.

Canon Medical's Aquilion Precision at the Radboudumc, Nijmegen, the Netherlands.

attributed to optimized detector elements and a data acquisition system redesigned for UHR CT," said Dr. Meijer. "At our department, UHR subtraction CTA is now routinely applied in the follow-up of patients with a cerebral aneurysm that has already been treated."

Detecting and analyzing complex aneurysms

A cerebral aneurysm can be detected if the patient has an intracranial subarachnoid hemorrhage, due to aneurismal rupture. A cerebral aneurysm may also be found as an incidental finding on CTA or MR Angiography (MRA). In both situations, it should be considered to treat the aneurysm to prevent aneurismal rupture or re-bleed. Cerebral aneurysms are treated either by surgical clip placement, endovascular stent or flow-diverter placement; or with coil-embolization, depending upon the location, size and configuration of the aneurysm.

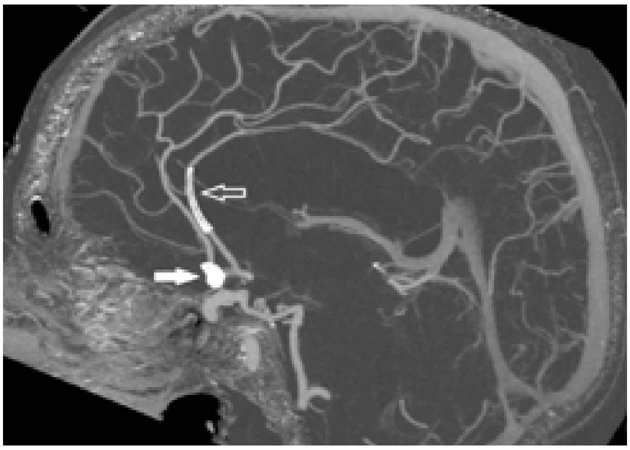
Patients with a cerebral aneurysm that has already been treated require follow-up to evaluate the level of aneurysm occlusion, or possible recanalization. If the aneurysm is not fully occluded, or if it is recanalized, the patient remains at risk of aneurysm rupture that can result in intracranial hemorrhage. In this case, additional treatment should be considered.

Replacing DSA with subtraction CTA

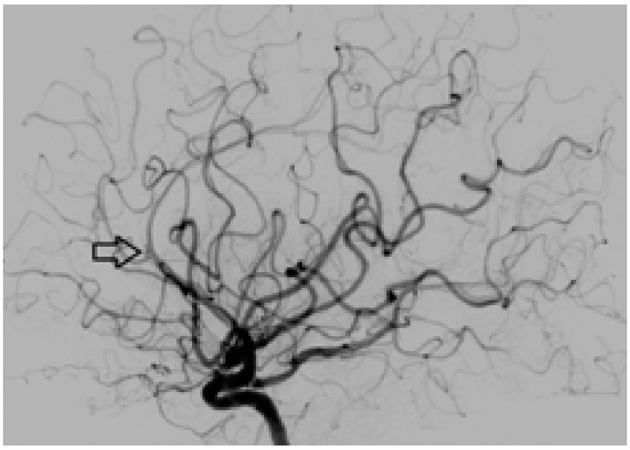
"Patients with a cerebral aneurysm are treated with a surgical clip, endovascular stent, or flow-diverter and undergo follow-up imaging with subtraction CTA," said Dr. Meijer. "Otherwise, the patients would require follow-up with conventional digital subtraction angiography (DSA) - an invasive and costly procedure that carries the risk of transient or permanent complications. DSA is only performed when the image quality of subtraction CTA is suboptimal, or if there is doubt about the aneurysm occlusion."

MRA is not feasible in these patients due to susceptibility artifacts from the surgical clips and stents. In the follow-up of endovascular coil-embolization treated aneurysms, MRA is the preferred imaging modality. However, some patients cannot undergo an MRI examination due to unsafe implants (e.g. a pacemaker), or because of claustrophobia. In these cases, subtraction CTA can be considered as a good alternative to DSA.

Radboudumc, Nijmegen, the Netherlands.



CT angiography scanned in ultra high resolution mode (0.25 mm collimation) demonstrated complete occlusion of an anterior communicating aneurysm treated with endovascular coil occlusion (white arrow) and complete occlusion of a small anterior cerebral artery aneurysm after endovascular flow-diverter placement (open white arrow). Single Energy Metal Artifact Reduction (SEMAR) and a model based iterative image reconstruction algorithm (FIRST) were applied.



Prior to flow-diverter stent placement, conventional DSA demonstrated a small anterior artery aneurysm.

"Together with neurosurgeons from our hospital, we have performed a prospective cohort study to evaluate the diagnostic accuracy of subtraction CTA using a conventional CT system (Aquilion ONE ViSION Edition) as compared to DSA in subjects with a cerebral aneurysm treated with a flow-diverter. A flow-diverter is an endovascular stent-like prosthesis used to treat cerebral aneurysms that are not eligible for coil-embolization.

In subtraction CTA (SURESubtraction), the pre- and post-contrast scans are automatically registered and subtracted. Subtraction CTA with a metal artifact reduction technique (SEMAR) proved effective in reducing flow-diverter metal artifacts, and diagnostic accuracy proved comparable to DSA for the evaluation of cerebral aneurysm occlusion after flow-diverter treatment. For this indication, subtraction CTA has now replaced DSA in our hospital.

A more confident evaluation

On our Aquilion Precision CT scanner SEMAR is also available, and when combined with a dedicated model based iterative image reconstruction algorithm (FIRST, Forward projected model-based Iterative Reconstruction SoluTion) and SURESubtraction, the image quality is superior to subtraction CTA at conventional spatial resolution. The median effective radiation dose estimate of our protocol is around 2.4 mSv (mean DLP 1150, k-factor 0.0021), which is well within the range of standard reference levels and comparable to other conventional CT scanners.

Therefore, we decided that every patient that requires subtraction CTA in the follow-up of a surgical clip or flow-diverter treated aneurysm is scanned in UHR mode on our Aquilion Precision scanner.

"In our initial experience, all cases have been of diagnostic image quality with the majority being rated as good to excellent. As compared to standard resolution subtraction CTA, smaller vascular structures and incomplete aneurysm occlusions are better delineated on UHR subtraction CTA, which is relevant for treatment planning. With the application of a model-based iterative image reconstruction algorithm (FIRST) and SEMAR, only limited artifacts resulting from the implanted materials are encountered, which allows a more confident evaluation of the treated aneurysm. Due to the increased spatial resolution, small and untreated cerebral aneurysms are also better depicted. For treatment planning it is important to accurately evaluate the shape of the aneurysm, to identify branches originating from the aneurysm and to appreciate the aneurysm's relation with surrounding vessels. Of course, our observations need to be verified in prospective cohort studies, which we are currently preparing in cooperation with our neurosurgical department."

"UHR mode scanning in head CTA is currently implemented in our routine clinical practice," said Dr. Smit. "Patients presenting with acute cerebral ischemic stroke are not routinely scanned on the Aquilion Precision scanner, because in this group of patients we perform perfusion CT, where a wide detector is preferred for whole brain coverage. Also, in case dynamic (4D-) CTA is indicated, e.g. for the evaluation of cranial arterio-venous shunts, the patients are primarily scanned on our wide-detector CT scanner. It is expected that increase in spatial resolution, with subsequent improved visualization of small vessels, can be beneficial in these groups of patients as well." //

Dr. Frederick Meijer
Neuroradiologist

Dr. Ewoud Smit
Resident in Radiology

A Brief History of Artificial Intelligence: From Perceptron to deep learning

Christophe Avare, PhD

Many different concepts lie behind the terms "Artificial Intelligence" (AI). Historically, AI was the hope to replicate the mechanisms of human thinking. All started in 1957, with the perceptron of Frank Rosenblatt at the Cornell Aeronautical Laboratory (Buffalo, NY, USA). Inspired by the cognitive theories of Friedrich Hayek and Donald Hebb, the perceptron was figuring a mono-layer neuron able to optimize its response by itself: supervised Machine Learning was born, or how to provide an expected output by adjusting a set of weights in order to minimize the error.

At that time, the human neuron individual behavior was just starting to be understood; the perceptron hence belongs to these neuro-mimetic or bio-inspired approaches tending to reproduce the biological mechanisms. This research was pursued through the decades, with all the material or software limitations related to the contemporary time. The main goal was to automate reasoning, to make deductions, only with a machine. Attempts were repeated in the 90's, especially via the Prolog language, but not with the expected results. Data were missing, computing power was too low. That was the period called "AI winter", characterized by disappointment, criticism and funding shrinking.

Today

Renewal of interest gradually increased again until 2012, with the contribution of three key researchers who collaboratively improved the neural networks techniques to lay the basis of Deep Learning: Yann LeCun, Yoshua Bengio and Geoffrey Hinton. Training was optimized, accuracy raised to match human capabilities, making the method ready to be spread among many different fields outside computer vision, like text comprehension or translation. Therefore, if the theory of AI was established in the middle of the 20th century, 50 more years were needed to access the neural networks training techniques, the huge amount of data and the large computing capacities necessary to reach the numerous levels of abstraction of Deep Learning. With Deep Learning and the scaling possibilities, Machine Learning was moving a step closer to its initial goal: Artificial General Intelligence (AGI).

The future

Nevertheless, 2017 represents the top of the Hype Curve and a lot of practical applications are still to be discovered. But, whatever the impressive current achievements are, a key building block is still missing: human-like understanding and reasoning. AGI is not there yet, all the current AI techniques are some form of supervised learning that often requires millions of examples to achieve objects recognition in images, when a two-year old toddler can learn to recognize them from a couple of examples. The key difference here is how we generalize concepts and connect them in different semantic contexts, while the current practice is based on optimization methods, somewhat black-box like, that try to minimize the learning error on a given and focused task. Though useful for some use cases, this does not scale to tens of thousands of tasks, and we still need to design a system that can reason by itself and discover non pre-existing insights and patterns.

As an example, we were recently able to map the full connectome of a nematode worm containing about 300 neurons and a few thousand synapses. Integrated into a small Arduino-powered robot, it started to behave like the real worm: response to stimuli (avoid obstacles), search for light (food), etc.

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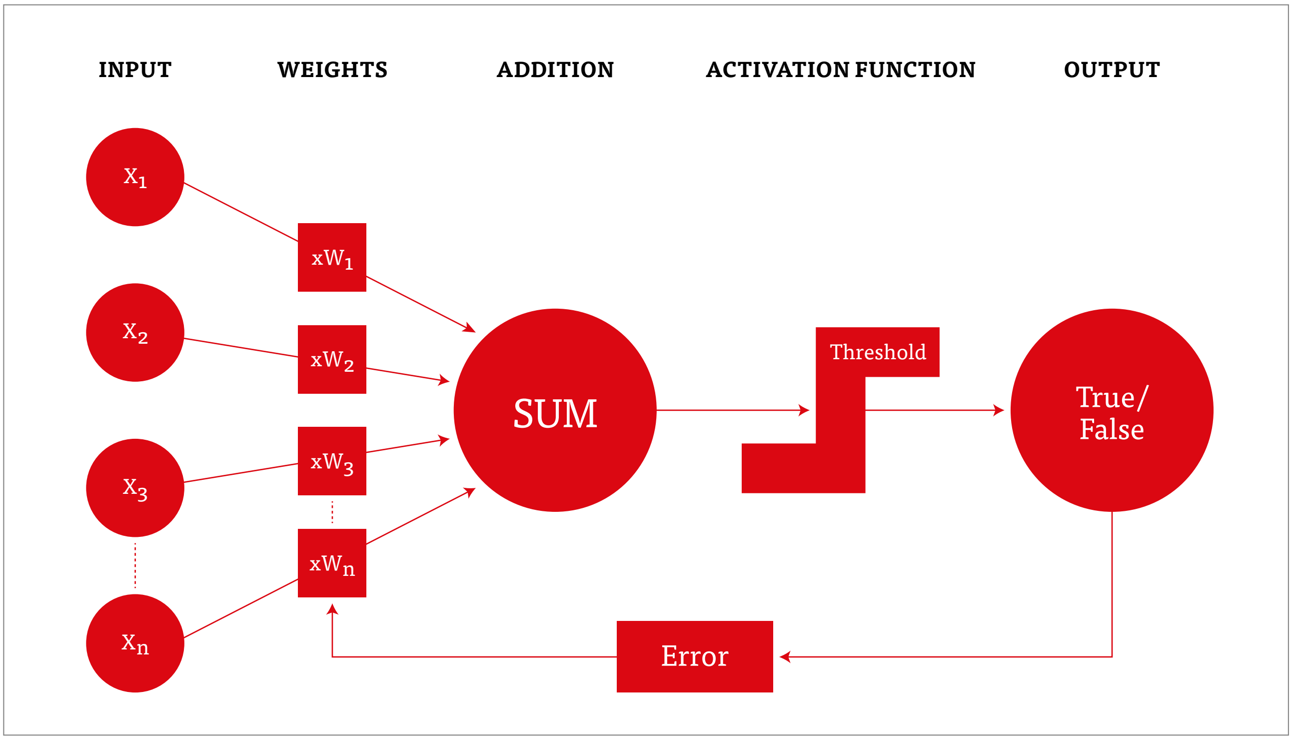

Figure 1, Schematic model of Rosenblatt's Perceptron. Perceptron is a single layer neural network acting as a linear classifier: it delivers a binary response. All inputs xi are multiplied by their respective weights wi. The resulting weighted sum is passed through a step activation function with a given threshold to produce the output. Iterative steps next adjust the weights in order to minimize the error.

We know how to do that, but we do not know to scale to the 100 billion of neurons and 1000 trillion synapses found in a human brain. In the future we will have to overcome the scaling issue. "The closer the wall, the more we see of it"!

How to go further?

Obviously, software alone is not the answer. The next breakthrough will certainly involve new hardware, be it quantum computers or, more probably, new materials like memristors that can closely mimic neurons at the nano-scale and move towards what is called "neuromorphic computing" [1].

We are currently bound to a very generalist computing architecture, which is highly energy-inefficient: if we wanted to replicate a very small part of the brain today, we would need a full data center and 20 MW of power to run it, when our brain only needs 20 W. This gap illustrates that we have hardly started to understand the direction we must take: new materials, new way of thinking and creating software and, why not, no more coding but some form of "education".

Meanwhile, even the top AI researchers concede that we are in a kind of dead-end with the current techniques but many disruptive approaches are around the corner. For example, an about-to-be-published paper [2] suggests a way to generalize object pose (aka object orientation and position) in image recognition. This is an important feature compared to the current techniques in convolutional networks which are only invariant to translation. Applied to medical images, this opens the door to a much more robust recognition of an organ (crucial if generating a mask) or anatomical landmarks without requiring millions of examples and achieving clinically compatible robustness.

Another transitional evolution will be to consider all these neuron networks or Machine Learning models as focused tools, and introduce an expert system above them by using another approach like Multicriteria Decision Making (a subfield of AI associated to game theory) to get closer to real reasoning. This is a requirement if we want to use genomics or population-based statistics in the diagnostic process, in addition to image-based biomarkers. To do that, we need to capture human expert knowledge – possibly using an automated technique learning from books! Multidisciplinary research will be necessary to link all these aspects and generate true innovations.

We are at the very beginning of a new adventure, a new cycle has just started, the future will be neither AI as it is conceived today, nor some Skynet or "A(I)pocalypse": self-consciousness is decades away! The next important steps will be to find novel materials and methods to better generalize knowledge, new ways to become, in essence, more bio-mimetic.

Learning with examples

Regarding database approaches, all the techniques based on supervised training need examples. In the early days, thousands or even millions of examples were necessary to reach the human scorings. From 2012, all this was significantly improved since the order of magnitude to learn efficiently is now thousands or even hundreds of examples. Nevertheless, gathering such large database remains an issue in the medical field, and quality is even more important than quantity. Remember: "garbage in, garbage out." With the current techniques, the increase in quality automatically goes through the increase of database size and quality, and obtaining the "ground truth" is still a manual – thus costly – operation.

Workflow for AI integration

In the medical imaging field, Deep Learning is essentially based on the famous neural networks. Their reliability depends on two main requirements: enough memory capacity to handle the calculations, and a proper training database adapted to the very specific images to be analyzed. It is also a fact that the nice applications in computer vision are not immediately transferable to medical images because they are 3D instead of 2D, anisotropic, generally fuzzy and noisy. Using those techniques will then require more than a simple adaptation. Regarding memory for example, 3D images cannot currently be digested at once, they must be fractionated into several parts; this complicates the training process.

There are no special technological problems to run in-house Deep Learning projects today, since everything is commoditized: the programs are widely available and easy to access via libraries. However, different steps must be controlled to integrate AI into a workflow. First, a specific type of expertise is mandatory to answer important questions: how to build a neural network? Which network family is the most interesting for the project? Second, the methodological steps of data processing must be well structured to correctly embed the small model in an application. Finally, upstream data must be available to train the system, in large quantity, and they are often difficult and time-consuming to collect.

Big Data are converted into training database, necessary for the neural networks to learn. Let's take the example of a set of medical images, injected for training a clinical process. After checking, a DICE similarity coefficient of 84% is reproducibly obtained, fine and suitable for diagnosis. But then, a new MR sequence appears in the protocols, which contains structural information different enough to make the DICE percentage collapse. This is not a software bug, nothing is wrong in there, you just need to acquire more data and re-train the whole system. Therefore, associated to AI, a necessary logistic process must be structured, to ensure a continuous update and improvement. This process must be included in the business model of AI companies, otherwise they cannot survive.

These three steps – neural nets expertise, embedding and data collection – are often much better achieved when the work is considered under a multidisciplinary angle.

What about OLEA?

Today

In a sense, Artificial Intelligence algorithms are already present in Olea Medical® products, since one should not forget that most of the mathematical basis of AI are the same as the optimization techniques implemented, for example, in registration or motion correction. AI and many of its sub-fields use foundational mathematics like linear algebra, Machine Learning or non-linear optimization algorithms.

Tomorrow

It will be very interesting to guess where, in our clinical offer, AI can be introduced in the future – that will also be the tricky part. Three criteria need to be met. First, and contrary to what is often thought, AI is not an end but a mean, it should not necessarily be visible for the user. Think about understanding user habits and automatically configuring the software: once you remove this capability, using another software feels unintuitive, generating some friction or just being painful.

Second, a fallback algorithm should always be available to replace AI in case it needs to be improved or further trained; ideally, all algorithms should be interchangeable, at least until the technology has been proven and accepted in the daily practice. The third criteria is about impact: using AI without impact is meaningless; real impacts deal with, for example, dividing post-processing times by 10, or getting significantly higher quality and robustness. In that context, if these three conditions are fulfilled, yes, we can think about including AI in our workflows, with maybe good surprises such as management of new sequences without additional coding...

Black Box syndrome

What is striking, from a mathematical point of view, is that all the algorithms used in Olea Sphere® software could be actually... learned. Deconvolution, for example, could probably be tuned and achieved with neural networks. But then, the problem is: how do we explain the procedure to a regulatory office? Why is this working? What mechanism is hidden behind the results? This black box aspect leads to many restrictions in the use of AI – at least today, where clinical evidence, validation tests and scientific studies are required for a commercially accepted product. But it started changing and we must be ready! //

Christophe Avare, PhD
Research and Innovation Director Olea Medical

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Aplio i900 – the ideal companion for research and for fetal cardiology

Prof. Dr Ulrich Gembruch is Director of the Clinic for Obstetrics and Prenatal Medicine at the University of Bonn, in Germany, and an internationally renowned expert in fetal cardiology. The trans-regional maximum care center treats 1,000 pregnancies with fetal malformations every year. Prof. Gembruch and his team have been performing scans using two Aplio i900 devices from Canon Medical Systems, since the end of 2017.

You are a specialist in prenatal medicine and Director of a trans-regional maximum care center. What are your specific requirements for the Aplio i900?
We see unusual cases from all across Germany. Due to our level of specialization in the areas of fetal cardiology, fetal anemia and complex prenatal interventions, we oversee some 2,000 high-risk pregnancies and around 1,000 pregnancies with fetal malformations every year. We use fetal cardiology to diagnose heart defects as accurately as possible. It is crucial that we provide parents with the best possible advice during the pregnancy. Unfortunately it still happens frequently that only postnatally the specific heart defect can be determined.

To be able to deliver this service, we always require the best ultrasound equipment and transducers to produce the best B-mode image. We are also working towards new research findings. Our goal is to improve our assessment of the severity of fetal heart disease caused by fetal myocardial function, so that we can opt for an early delivery or for intrauterine intervention, as appropriate.

Can you give specific examples of what you mean?
Rather than having to wait for the established, but delayed findings, from the Doppler ultrasound of the ductus venosus, we want clarity regarding the fetal heart muscle function at an earlier stage. That is important in placental insufficiency, for example; what is going on in the background when a baby's heart is pumping hard with a high heart rate and a hemoglobin value of four instead of 12? Knowing the level of myocardial function is also helpful with twin-to-twin transfusion syndrome, as this makes it easier to assess the severity of the disease. At the moment, however, we don't have a reliable method for this. Although the introduction of new techniques like Tissue Doppler Imaging and Speckle Tracking enable the ever more accurate examination of myocardial function, both globally and segmentally. However, there is still a lot to come in this area of cardiac function diagnostics; that is an opportunity for us, looking to the future.

The Aplio i900 has been well designed to meet these scientific requirements. In terms of echocardiography, the research-related possibilities for the device are infinite.

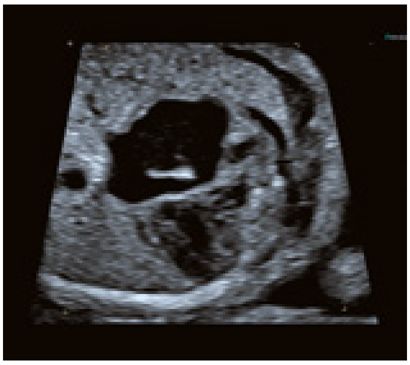
How satisfied are you with the image quality?
The B-mode image from the Aplio i900 is excellent and extremely detailed. At the moment, the imaging it provides is undoubtedly the best on the market. The highly accurate color presentation creates a precise image of the vessels, and turbulence in the blood flow is also displayed clearly. Generally speaking in terms of ultrasound technology, we can now detect things clearly in the 13th week of pregnancy which, ten years ago, we wouldn't have seen until the 20th week. In early pregnancy, we can see severe malformations caused by chromosome disorders we have never been able to see before as these cause early miscarriages.

Has this early diagnosis had a concrete impact on treatment?
The earlier we can diagnose a malformation, the sooner the parents can cope with it. Numerous studies have shown that terminating a pregnancy in the 13th week can be handled better than in the 20th week.

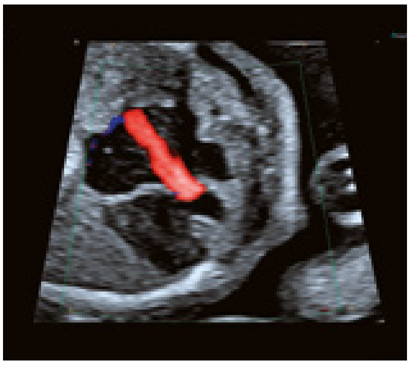
In some cases, early diagnosis can also result in specific therapeutic approaches; for example, for megacystis (Greek, literally meaning 'abnormally large bladder'). This is where a narrowing or anomaly of the urethra in the first few weeks of pregnancy results in the dramatic enlargement of the bladder. At the same time, urine collects in the kidneys and can cause permanent damage to them. We can insert a catheter into the baby's bladder from as early as the 14th week of pregnancy, allowing the urine to drain and preventing further damage to kidney function. The quantity of amniotic fluid returns to normal, enabling the survival of babies, who would have died in the past.

Another example of early therapeutic options is TRAP sequence (parasitic twin), which is the most severe malformation in monozygotic twins with a shared placenta. An inadequate blood flow means that one of the twins often has no head or heart. The parasitic twin is supplied with blood from the healthy twin through vascular connections in the placenta and can reach a significant size and weight. This results in an increasing cardiac load for the healthy twin (whose heart is pumping harder), as the pregnancy progresses. Without treat-

AVSD1 – Profile image of the fetus with a hypoplastic nasal bone.



AVSD2 – Four-chamber view of the diastole with a closed joint AV valve.



AVSD3 – The color Doppler examination shows a holosystolic insufficiency of the joint AV valve.

ment, this can cause death. We can now use lasers to cut the umbilical cord of the TRAP twin, preventing cardiac insufficiency in the healthy fetus.

Is the Aplio i900 easy to operate?

We have been using two Aplio i900 devices for a few months now and we are very satisfied with them. My team and I have access to five ultrasound rooms with equipment from a range of manufacturers; we continually switch between them, so ease-of-use is extremely important. The devices are well designed and easy to understand, and they have a good selection of transducers.

What about patients who are difficult to scan? Are you satisfied with the image quality in those patients as well?

If we scan below the abdominal apron, using the appropriate transducer produces good images, even with a thick abdominal wall. We can see the four chambers and a clear view of the major vessels, even in obese women. However, we don't often see patients with a BMI over 50. But if necessary, we can also scan vaginally with good results. //

Prof. Dr. Ulrich Gembruch.

About Prof. Gembruch:

- *Prof. Dr Ulrich Gembruch has been Professor of Gynecology and Obstetrics and Director of the Clinic for Obstetrics and Prenatal Medicine at the University of Bonn since 2002.*
- *His main areas of research and work include complex prenatal interventions, fetal cardiology and complicated multiple pregnancies.*
- *Gembruch and his colleagues have decades of experience in the field of prenatal medicine and use the latest fetal treatments: transfusion of blood products (erythrocytes, thrombocytes), insertion of fetal shunts/ catheters (megacystis, hydrothorax), and balloon dilatation of fetal heart valves. (Source: Leopoldina, the German National Academy of Sciences).*

Low Contrast Volume, Low Dose Acquisition with a Monitored Injection of 20 ml of Contrast Medium for Pulmonary Embolism Detection with Wide Detector CT Angiography:

Feasibility study with Diagnostic Performance and Image Quality Assessment

Edouard Germain MD, Pedro Augusto Gondim Teixeira MD, PhD, Rachid Keichidi,MD, Annelise Veronese MD, Lionel Nace MD, PhD, Alain Blum MD, PhD.

Pulmonary embolism (PE) is a common disorder, with an incidence of 600 to 630 thousand patients per year in the United States [1, 2]. It is potentially serious, leading to death in 15% of cases within 3 months of diagnosis, [1, 2]. Thoracic CT angiography (CTA) is currently considered the gold standard for non-invasive diagnosis, however, this method has three main limitations [1, 3-7]. The use of ionizing radiation, with an effective dose on average greater than 4 mSv [8]. The need for an intravenous injection of iodinated contrast agent, which is relatively contraindicated in patients with renal [9] and/or cardiac insufficiency [10]. Finally, images can be of suboptimal quality due to motion artifacts, beam hardening artifacts, or insufficient enhancement of pulmonary arteries [11-13].

Quality improvement in thoracic CTA for PE is a recurring subject in the literature [3, 4]. Acquisition parameter monitoring is necessary to achieve optimal image quality [14, 15]. Regarding irradiation, systematic recording and analysis of the delivered dose is made easy by the use of dedicated software, and is accompanied by a global reduction in dose through protocol optimization [15]. Software for real-time monitoring of contrast injection parameters is also available, but the impact of these tools on the quality of opacification of pulmonary arteries in CTA has not yet been evaluated [16]. Injection parameter monitoring is all the more useful with low injection volumes and high injection rates.

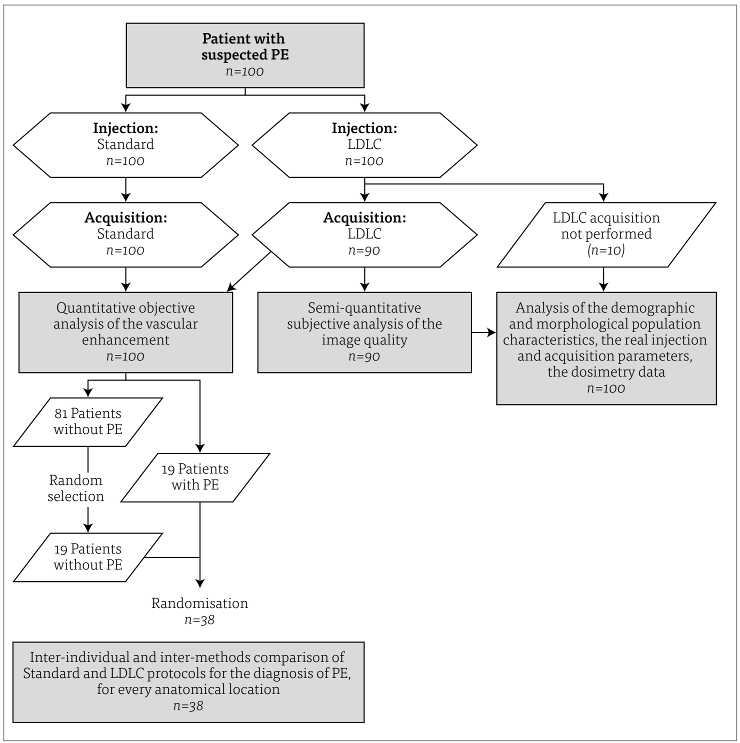


Figure 1, Flow chart summarizing the patient selection process (PE = Pulmonary Embolism; LDLC = Low Dose Low Contrast).

The exponential increase in the number of CTA studies seen in the last decades support the use of less harmful protocols, especially for patients at risk (young age, pregnant women, borderline renal function) and in cases of low suspicion level [17]. The objective of this study was to determine the diagnostic performance of thoracic CTA with a low dose low contrast volume (LDLC) protocol using a dedicated software for contrast injection monitoring.

Material & methods

Patients

In this study we performed a retrospective analysis of 100 consecutive thoracic CTA studies, referred for the diagnosis of PE (Figure 1).

Reports of these examinations were evaluated retrospectively to identify patients with a positive diagnosis of PE. Nineteen such cases were identified and formed the study group. A control group of the same size was created by randomly selecting 19 patients from the 81 with a CT angiographic study negative for PE.

Image acquisition

All examinations were performed using a 320 detector-row CT scanner (Aquilion ONE™, Canon Medical Systems. Patients were positioned supine, arms above the head and the acquisition protocol consisted of two successive injected thoracic acquisitions separated by an interval of 3 to 5 minutes.

Figure 2, Injection monitoring report of a CTA performed with the LDLC protocol. Injection A represents the iodinated contrast medium injection and injection B represents isotonic saline injection. A) Table summarizing the programmed and the actual injection volumes (ml) and flow rates (ml/s)(Pressure Limit = programmed pressure limit not to exceed in the manifold and the injection system). B) Real time pressure (psi) and flow (mL/s) graphs of the contrast and saline injection. C) Injection summary, on the left peak pressure and peak flow rate values. The presence or absence of anomalies during injection (transient events) is presented. The right-hand side summarizes the volume of contrast and saline loaded into the injector before (loaded), then used in it (used), and finally the volume remaining in each compartment of the injector after the injection (remaining). The total volume injected (total fluid) is also presented.

In the first acquisition (Low dose low contrast volume protocol – LDLC protocol) two free-breathing 16 cm volumes (in the z-axis) in sequential volume mode (no table feed) centered at the level of the pulmonary trunk were acquired. The first volume was triggered automatically 2 s after detection of an enhancement threshold of 250 Hounsfield Units (HU) in a region-of-interest (ROI) positioned manually in the pulmonary infundibulum using a bolus tracking technique [18]. The second volume was triggered automatically 1.6 s after the first volume.

Two volumes were acquired to ensure optimal opacification of the pulmonary arteries and branches. The gantry rotation time was 0.35s and a half reconstruction technique was used, thus volume acquisition time was 0.175 seconds [19]. The following acquisition parameters were used: 0.5 mm slice thickness in acquisition and reconstruction, 400 mm field-of-view, 512 × 512 matrix. Tube output was 80 kVp and a mAs value corresponding to twice the patient weight. The images were reconstructed with a soft tissue kernel, using an iterative algorithm (AIDR 3D, Canon Medical Systems). Iodinated contrast agent (Iopromide, 370 mg iodine / mL, Bayer Healthcare, Leverkusen, Germany) was injected using an automatic injector (Medrad Stellant CT Injection System, Bayer Healthcare, Leverkusen, Germany) via a peripheral or central venous line with 20 mL of iodinated contrast medium (ICM) immediately followed by a bolus of 20 mL of isotonic saline (NaCl) injected at a rate of 5 mL/s.

The second acquisition (standard protocol) was performed in helical mode from lung apex to lung base in breath hold after deep inspiration with the following parameters: 1 mm slice thickness reconstructed every 0.8mm, 1.4 pitch, 0.5s gantry rotation time, 400 mm field-of-view and 512 × 512 matrix. Tube output was 100 kVp and 100 to 500 mA. Images were reconstructed with the same iterative algorithm. The acquisition was triggered automatically according to the bolus tracking method 7 s after detection of an enhancement threshold of 130 HU in a ROI positioned in the left ventricle [20] (incompressible table repositioning time). The same iodinated contrast agent and the same injection pump were used. The total injection volume of the standard protocol was 100-120 mL. The DLP was recorded for each patient and for each protocol.

These two acquisitions were carried out during a test period with total delivered dose lower than the national recommendations [21, 22]. In our institution, studies based on anonymized data, obtained with acquisition techniques that respect the clinical recommendations, do not require evaluation by the ethics committee.

Image analysis

Image analysis was performed by two radiologists with 2 and 6 years of clinical experience in the interpretation of thoracic CT.

A PACS (Synapse, Fujifilm Medical Systems, Japan) was used to read images from the 38 patients evaluated for the diagnosis of PE (19 with PE and 19 without). Readers were blind to all patient data and evaluated the images from the two acquisition protocols in two reading sessions. All pulmonary segments were considered in the analysis, taking into account emboli location.

Each zone analyzed was classified as follows:
1 - Pulmonary embolism
2 - No pulmonary embolism
3 - Doubtful
4 - Not analyzable

The identified emboli were classified, according to the artery caliber in which they were located, into central (pulmonary trunk, pulmonary arteries, lobar arteries), segmental arteries, or sub-segmental.

Injection parameter monitoring

A workstation (Certegra Workstation, Bayer Healthcare, Leverkusen, Germany) connected to the automatic injector and the CT scanner was used to collect the actual injection parameters. The volume (mL), mean flow (mL/s), maximum flow (mL/s) of the iodinated contrast agent and saline boluses were recorded (Figure 2).

		LDLC Protocol				Standard Protocol			
		1	2	3	4	1	2	3	4
Reader 1	Global (=All location combined)	19 (50%)	19 (50%)	0	0	20 (52.6%)	18 (47.4%)	0	0
	Central	10 (26.3%)	28 (73.7%)	0	0	10 (26.3%)	28 (73.7%)	0	0
	Segmental	27 (14.2%)	159 (83.7%)	0	4 (2.1%)	40 (21.1%)	146 (76.8%)	0	4 (2.1%)
	Sub-segmental	33 (17.4%)	113 (59.5%)	3 (1.5%)	41 (21.6%)	49 (25.8%)	118 (62.1%)	1 (0.5%)	22 (11.6%)
Reader 2	Global (=All location combined)	16 (42.1%)	22 (57.9%)	0	0	20 (52.6%)	18 (47.4%)	0	0
	Central	10 (26.3%)	28 (73.7%)	0	0	10 (26.3%)	28 (73.7%)	0	0
	Segmental	38 (20%)	144 (75.8%)	6 (3.1%)	2 (1.1%)	48 (25.3%)	142 (74.7%)	0	0
	Sub-segmental	25 (13.2%)	116 (61%)	13 (6.8%)	36 (19%)	48 (25.3%)	142 (74.7%)	0	0

Table 1, Emboli distribution concerning PE diagnosis for each reader and for each protocol according the location (1 = Pulmonary embolism, 2 = No pulmonary embolism, 3 = Doubtful, 4 = Not analyzable) (PE = Pulmonary Embolism; LDLC = Low Dose low Contrast).

Location	Kappa
Central PE (segmental included)	0,723
SRL Segmental	0,465
SRL Subsegmental	0,697
ML Segmental	0,328
ML Subsegmental	0,137
IRL Segmental	0,600
IRL Subsegmental	0,561
SLL Segmental	0,627
SLL Subsegmental	0,709
ILL Segmental	0,626
ILL Subsegmental	0,520
Total Segmental	0,715
Total Subsegmental (= Peripheral)	0,650
Global (= All locations included)	0,776

Table 2, pInter-reader agreement (readers 1 and 2) for the diagnosis of PE for each location in the LDLC protocol, according the kappa agreement coefficient (PE = Pulmonary Embolism; SRL = Superior Right Lobe; ML = Middle Lobe; IRL = Inferior Right Lobe; SLL = Superior Left Lobe; ILL= Inferior Left Lobe).

Image quality analysis

The quality of elevation and visualization of all the branches of the pulmonary arterial tree was classified into five categories [23]:

1 - Unacceptable image quality, interpretation impossible.
2 - Poor image quality, interfering with interpretation.
3 – Average but sufficient image quality without influence on interpretation.
4 – Good image quality.
5 – Excellent image quality.

Quantitative analysis pulmonary arterial vascular enhancement quality was performed by measuring the HU value and standard deviation within an elliptical ROI placed in the left pulmonary artery and another at the left lower lobe artery in both acquisition protocols.

Results

Patients

In the initial group of 100 patients, the median age was 63 years, with a sex ratio of 1/1. Their median body mass index (BMI) was 24.65 kg/m^2. The LDLC protocol was not performed in ten patients because pulmonary artery enhancement did not reach the 250 HU threshold. The median age of these patients was 60.5 years. None had PE.

In the 38 patients compared for the diagnosis of PE, there were no statistical difference between the PE group and the no PE group for age, BMI, and sex ratio.

Diagnosis of pulmonary embolism

The distribution of the identified emboli for each reader and for each protocol is reported in Table 1. The final diagnosis of PE was never classified as doubtful or not analyzable. The number of emboli detected was slightly larger with the standard compared to the LDLC protocol, without statistical difference.

The inter-reader agreement for the diagnosis of PE for each location in the LDLC protocol is reported in Table 2. The statistical significance threshold was reached for all kappa comparisons.

The inter-method agreement was considered good for both readers (Kappa = 0.698 and 0.791 for readers 1 and 2 respectively).

The sensitivity and specificity of the LDLC protocol for the diagnosis of PE were 80-85% and 100% for readers 1 and 2. The sensitivity was 81-100% for central and 67-78% for peripheral emboli for readers 1 and 2 and the specificity was 100% for both readers regardless of embolus location. There were four false negative PE diagnosis with the LDLC protocol for reader 1 and one for reader 2. These false negatives resulted from the combination of poor image quality and low density vascular enhancement (Figure 5). None of these false negatives were due to the limited coverage of the LDLC protocol.

Image quality

The image quality of the standard protocol was considered good or excellent in all the included cases. The results of the semi-quantitative subjective image quality analysis of the LDLC protocol are reported in Table 3. Almost all examinations (94.5%) quality was graded 3 or higher with no influence on image interpretation (Figures 3 and 4).

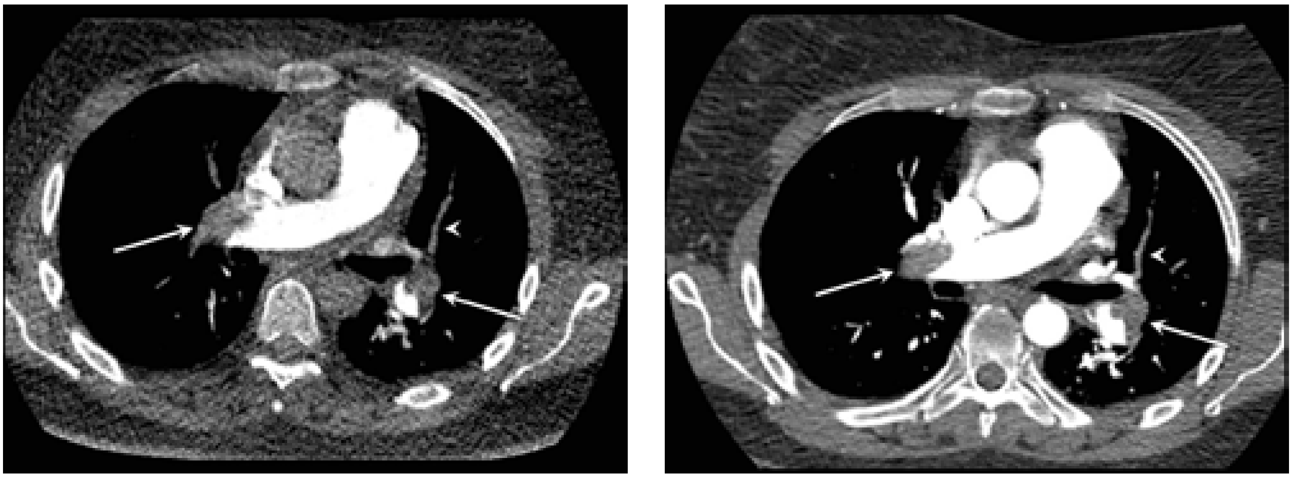


Figure 3, Case of PE in a 42 y.o. woman with a body weight of 78 kg, a BMI of 32.1. A) LDLC protocol obtained with 80 kVp, 117 mAs leading to a DLP = 136 mGy.cm and an effective dose = 1.9 mSv. B) Standard protocol performed at 100 kVp with a DLP = 249 mGy.cm and an effective dose = 3.5 mSv. Note the bilateral proximal PE (white arrow) and subsegmental PE (arrowhead), visible in both acquisitions, with good vascular enhancement.

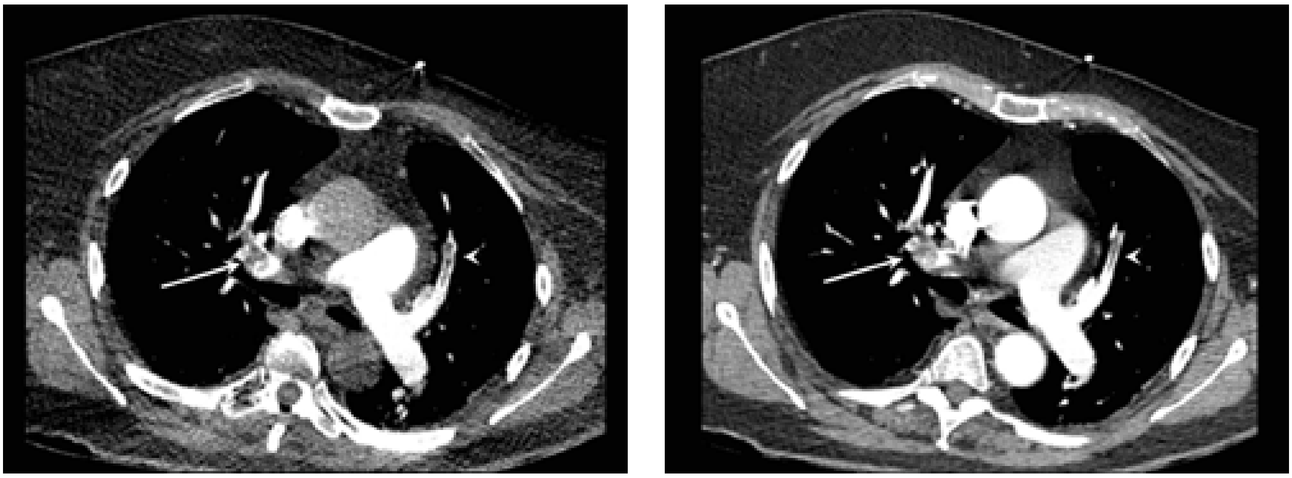


Figure 4, Case of PE in a 71 y.o. woman with a body weight of 82 kg, a BMI of 34.1. A) LDLC protocol obtained with 80 kVp, 192 mAs leading to a DLP = 212 mGy.cm and an effective dose = 3.6 mSv. B) Standard protocol performed at 100 kVp with a DLP = 481 mGy.cm and an effective dose = 8.2 mSv. Note the right upper lobar PE (white arrow) and segmental PE (arrowhead) on the left, visible in both acquisitions, with good vascular enhancement.

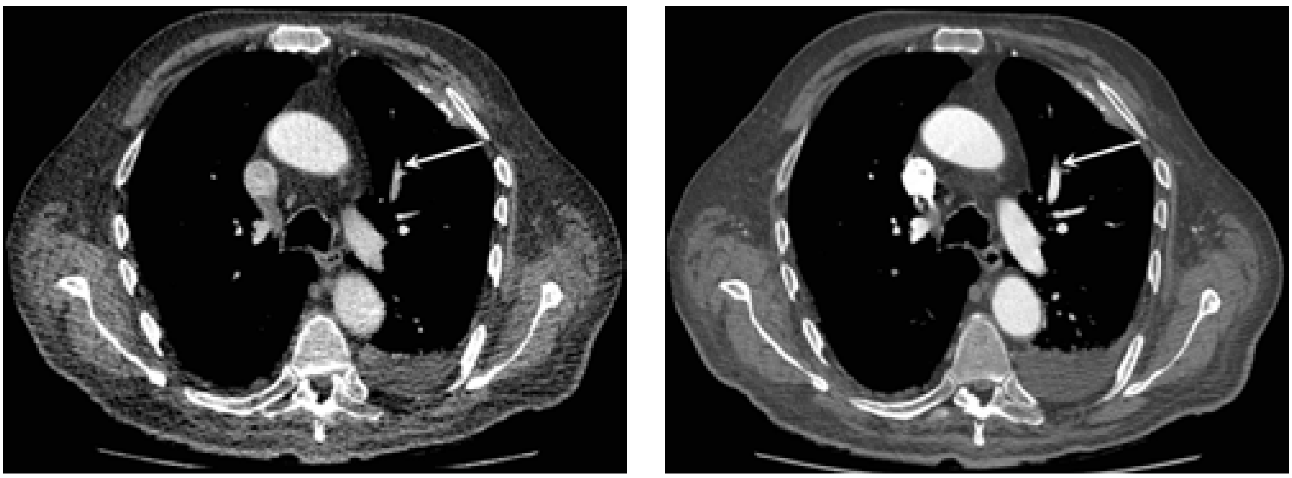


Figure 5, Case of false negative PE diagnosis in an 83 y.o man with a body weight of 85 kg, a BMI of 23.5. A) LDLC protocol obtained with 80 kVp, 192 mAs leading to a DLP = 212 mGy.cm and an effective dose = 3.6 mSv. B) Standard protocol performed at 100 kVp with a DLP = 357 mGy.cm and an effective dose = 6 mSv. The vascular enhancement and the image quality are worse in (A) than (B), thus the sub-segmental PE (white arrow) visible in (B) is not seen in (A).

The increase of BMI and male sex were significantly responsible for degradation of image quality.

In the 10 patients not imaged with the LDLC protocol due to insufficient enhancement of the pulmonary infundibulum, there was no clear factor responsible for the enhancement insufficiency. Although the weight and BMI were higher in these patients, the difference was not statistically significant.

The mean enhancement density in the left pulmonary artery was 23% higher in the standard protocol compared to the LDLC protocol. Independently of the acquisition protocol, 85% of the LDLC and 98% of the standard studies had an enhancement value higher than 250 HU for each of the two measurement sites.

The injection parameters monitored were similar (median contrast injection rate = 4.4 mL/s, median saline injection rate = 4.3 mL/s), or even identical (injected contrast volume = 20 ± 0 mL, injected saline volume = 20 ± 0 mL) to the parameters programmed in the injection pump. The injection parameters evaluated were not significantly related to the degradation of image quality.

The mean image noise was twice as high in the LDLC protocol (SD = 50.85) compared to the standard protocol (SD = 25). The median DLP of the LDLC protocol (193 mGy.cm) was about 1.6 times lower than that of the standard protocol (306.5 mGy.cm).

Discussion

The LDLC protocol uses a 56% lower dose and an injected contrast volume 75% lower than the standard protocol, with a sensitivity and specificity for the diagnosis of PE of 80-85% and 100%. Sensitivity and specificity for the identification of central emboli, which yields the higher patient mortality and morbidity, were even higher (81-100% and 100%). Inter-method and inter-reader agreement of the LDLC protocol were good, outside subsegmental locations.

The sensitivity for the diagnosis of subsegmental PE was lower (78% for reader 1 and 67% for reader 2), allegedly due to lower image quality and suboptimal enhancement in peripheral arteries. Interestingly, lung coverage limited to 16 cm was not responsible false negatives cases encountered and was not a limitation in this population.
The clinical significance and the risk-benefit ratio of anticoagulant therapy with subsegmental emboli remains controversial [25-29].

Several studies have shown that it is possible to significantly reduce the volume of contrast agent injected for CTA [30-33]. The iodine load delivered is markedly low in the LDLC protocol, with a total iodine mass of 7.4 g, reducing nephrotoxicity. Such protocols could increase the availability of CTA in patients with a borderline renal function which constitutes a relative contra-indications for iodinated contrast injection [9, 34]. The total injected volume of 40 mL could be suited for imaging patients with a precarious hemodynamic status (cardiac insufficiency, cardiac overload, etc.) [35].

In the study by Saade et al., the low contrast dose protocol provided a better opacification of the pulmonary arteries than the standard protocol, but in the protocol proposed by these authors there was an initial test-bolus, followed by a calculation to determine the volume to be injected (between 12 and 55 mL). Thus the total iodine dose was higher (from 11.2 to 26.25 g) than that used in LDLC protocol [32]. The DLP of the LDLC protocol was also considerably low, which may be interesting in situations radioprotection is paramount (e.g. pregnancy, pediatric patients, chronic diseases) [36]. Finally, the very short volume acquisition time (0.175s) limit kinetic artifacts and allow an acquisition in spontaneous breathing, which can be beneficial in dyspneic patients. In a context of an ever increasing number of patients with suspected PE the LDLC protocol could be used as a screening method in patients with relative contra-indications to conventional CTA [37].

As expected, image quality was significantly lower in patients with high BMI. However, none of the studied variables explained the non-triggering of the volume acquisition due to insufficient enhancement in the pulmonary artery. The hypothesis of an injection dysfunction was refuted since potential discrepancies between injector settings and real time data. Injection monitoring can be useful as part of a quality approach in protocols with a low contrast volume, helping identify injector malfunction or extravasation.

There are several limitations to this study. First, the confirmation of the diagnosis of PE by pulmonary angiography was not possible in view of the current recommendations for diagnostic workup in patients with this condition. Several studies have shown that the performance of the CTA for the diagnosis of PE is high which legitimate the use of conventional CTA as gold standard [6]. Pregnant women, patients with cardiac insufficiency and renal insufficiency, for whom the volume acquisition protocol could be an interesting

Image Quality	Criteria	Patients (n)	Age (years)	Weight (Kg)	BMI	mAs	Real Volume of ICMA (mL)	Real Flow Rate of ICMA (mL/s)
5	Excellent image quality	35 (38,9%)	67,6 ± 17	64,25 ± 20,32	24 ± 3,82	159,4 ± 34,5	20 ± 0	4,3 ± 0,2
4	Good image quality	28 (31,1%)	57,8 ± 18,6	70,5 ± 13	24,4 ± 4,63	158,2 ± 32	20 ± 0	4,1 ± 0,5
3	Average but sufficient image quality without influence on interpretation	22 (24,5%)	64,6 ± 15,1	80,4 ± 15	26,6 ± 5,37	158,3 ± 34,5	20 ± 0	4,3 ± 0,16
2	Poor image quality, interfering with interpretation	5 (5,5%)	58,2 ± 30	87,8 ± 12,1	32,16 ± 3,5	166,6 ± 40,5	20 ± 0	4,3 ± 0,13
1	Unacceptable image quality, interpretation impossible	0	-	-	-	-	-	-

Table 3, Semi-quantitative subjective image quality analysis of the LDLC protocol reported to demographic characteristics (age), morphologic characteristics (weight and BMI), tube output (mAs), and real injection parameters (volume and flow rate) (values indicated on mean +- standard deviation). (BMI = Body Mass Index; ICMA = Iodinated Contrast Media Agent).

alternative, were not included in this preliminary study because of the contraindication to injection of the standard protocol. Further studies are necessary to confirm the interest of low dose, low contrast volume CTA in these patient groups. New generation full model-based iterative reconstruction algorithms and the reduction of the number of acquisition volumes could lead to further reduction in the delivered dose but were not evaluated in this study [38].

The LDLC protocol is technically feasible with narrower detector systems but a reduction in z-axis coverage could reduce diagnostic performance. Even though the treatment of isolated subsegmental embolus is controversial, multiple subsegmental emboli are generally treated. Although the LDLC protocol missed some subsegmental emboli, in most of the patients evaluated (four exceptions for reader 1, and one for reader 2) there were emboli elsewhere allowing a diagnosis of PE limiting the clinical impact of this limitation.

In conclusion, low dose, low contrast volume CTA similar to a test-bolus protocol offers a good performance and good reproducibility for the diagnosis of PE. In central PE an overall sensitivity and a specificity of 81-100% and 100% could be reached indicating that the performance of this method is comparable to that of standard CTA. Although more studies are still necessary, LDLC protocol may be an interesting option for patient screening and for those whom iodine injection, contrast volume and ionizing radiation represent relative contra-indications for conventional CTA. //

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Canon and Olea Medical's industry leading collaboration in MRI post-processing

The introduction of Olea Vision puts Canon Medical and Olea Medical in an industry leading position in MRI post-processing. The development brings more accurate and cost-effective diagnoses in clinical practice and research and less stress on patients and healthcare professionals. There are 40 completely new and unique features in the Olea Vision that are suitable for Canon Medical's M-Power MRI systems.

The new Olea Vision® has established an unparalleled position for Canon Medical and Olea Medical in the MRI market, with 40 applications in the package," said Dirk Berneking, Senior Manager MRI at Canon Medical Systems Europe.

Canon Medical and Olea Medical: The best of both worlds

Canon Medical is a key player in the MRI market, while Olea Medical is renowned for providing the most advanced post-processing solutions for MRI. Together, they offer the best of both worlds.

Olea Medical has been a part of Canon Medical since 2015. One result of the integration of both companies' R&D teams are many innovative solutions and products that play an important role in the development of MRI systems. The latest Olea Vision development is an impressive example of how truly effective this collaboration is.

"Olea Vision is the market's most pertinent tool for MRI visualization".

Olea Medical

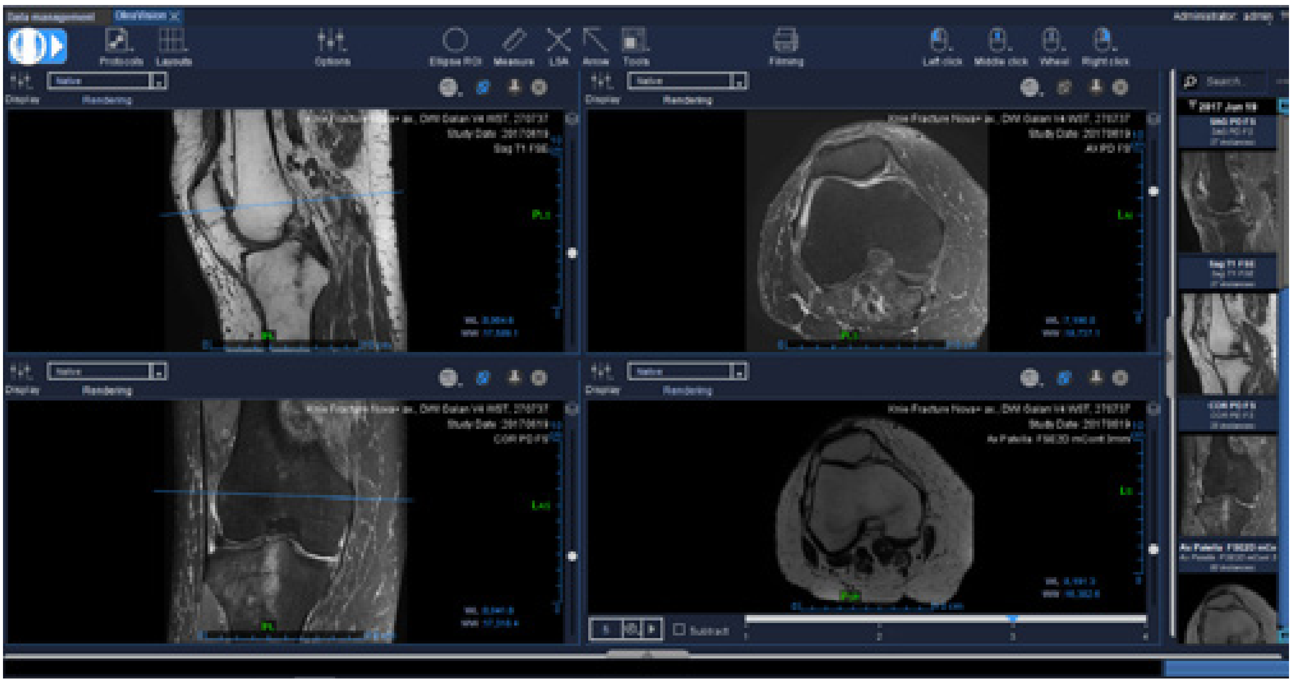


Fig. 1, Olea Vision user interface, adapted to Canon Medical's M-power user interface.

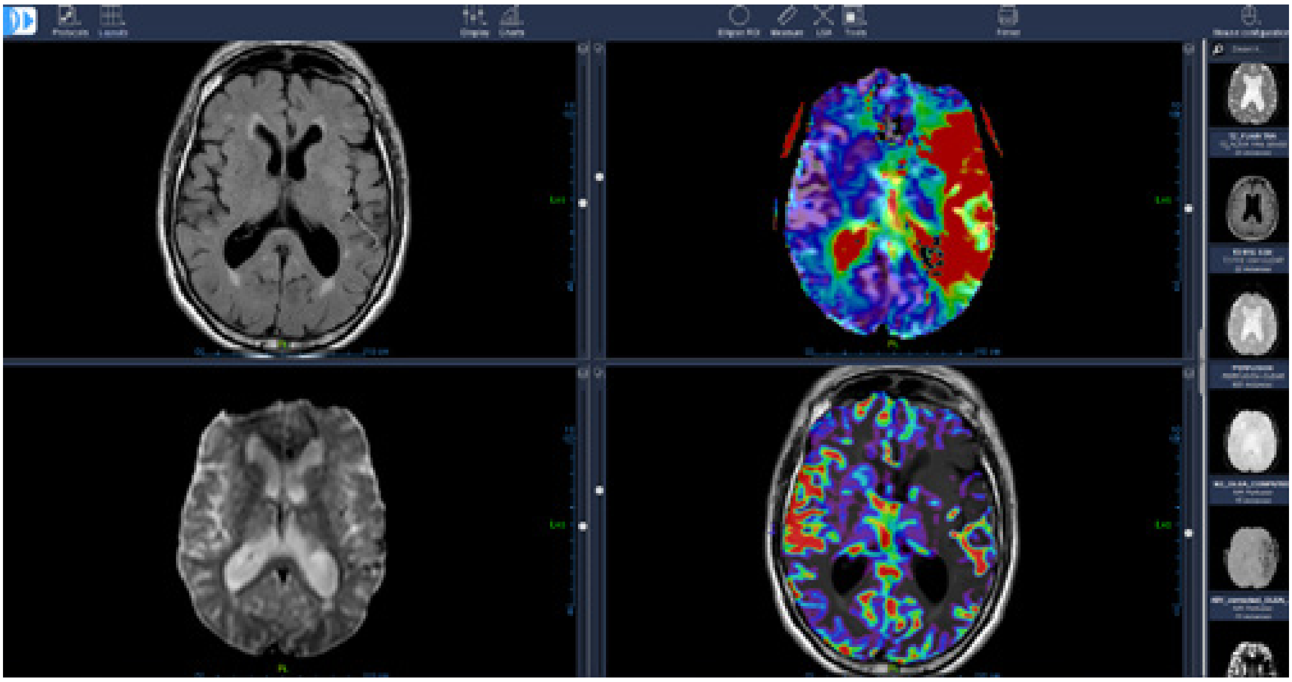


Fig. 2, Olea Vision user interface, adapted to Canon Medical's M-power user interface.

Excellence + excellence = excellence

Canon Medical and Olea Medical have long been aware of the need to improve post-processing in MRI. Both global brands decided to strengthen their collaboration based on the conviction that excellent hardware and excellent software equal excellent performance for patients.

"Olea Vision is the market's most pertinent tool for MRI visualization," said Eric Marchand, Olea Medical Program Director). "It is a highly customizable 2D, 3D, 4D DICOM viewer with user-defined hanging protocols that offer several functionalities, such as easy navigation in any DICOM series, 3D data loading and visualization, image manipulation and reconstruction.

It also includes subtraction for enhanced diagnostic capabilities. The Olea Vision viewer is perfectly adapted to Canon Medical's MRI M-Power™ user interface (fig.1)."

Olea Vision can be applied to upgrade the MRI systems of existing Canon customers to improve their capabilities vastly.

Unique New Applications

Unique features also available include a Bayesian model, IVIM (intravoxel incoherent motion) limitation and computed MRI Nova+. The outstanding Olea Medical software package supports Diffusion Tension Imaging (DTI), advanced perfusion studies, and permeability studies, and tissue-mapping in clinical practice, and has a unique new breast module. All applications have a high degree of user-friendliness and intuitiveness.

"Olea Vision has taken one year to develop and has involved the expertise and superb collaboration of a diverse team made of R&D specialists, technical engineers, medical specialists at Olea Medical and Canon Medical," said Rémi Rudelle, Olea Medical Project Manager.

Availability

Currently, 40 applications are available in Olea Vision as a trial-versions with an electronic license by mail.
Canon Medical will provide the new Olea Vision with newly purchased Canon MRI systems, as standard. //

Excellent images are possible even with obese patients

Dr. Stefan Völckers is in charge of prenatal medicine at abts+partner in Kiel, Germany. He has been performing scans using the Aplio i800 from Canon Medical Systems, since summer 2017. Prior to that, he spent 15 years using another established ultrasound system. As a specialist in Gynecology and Obstetrics, he says that the image quality is excellent even in obese patients, who are difficult to scan. He is also impressed by the opportunities for early cardiac diagnostics in the first trimester.

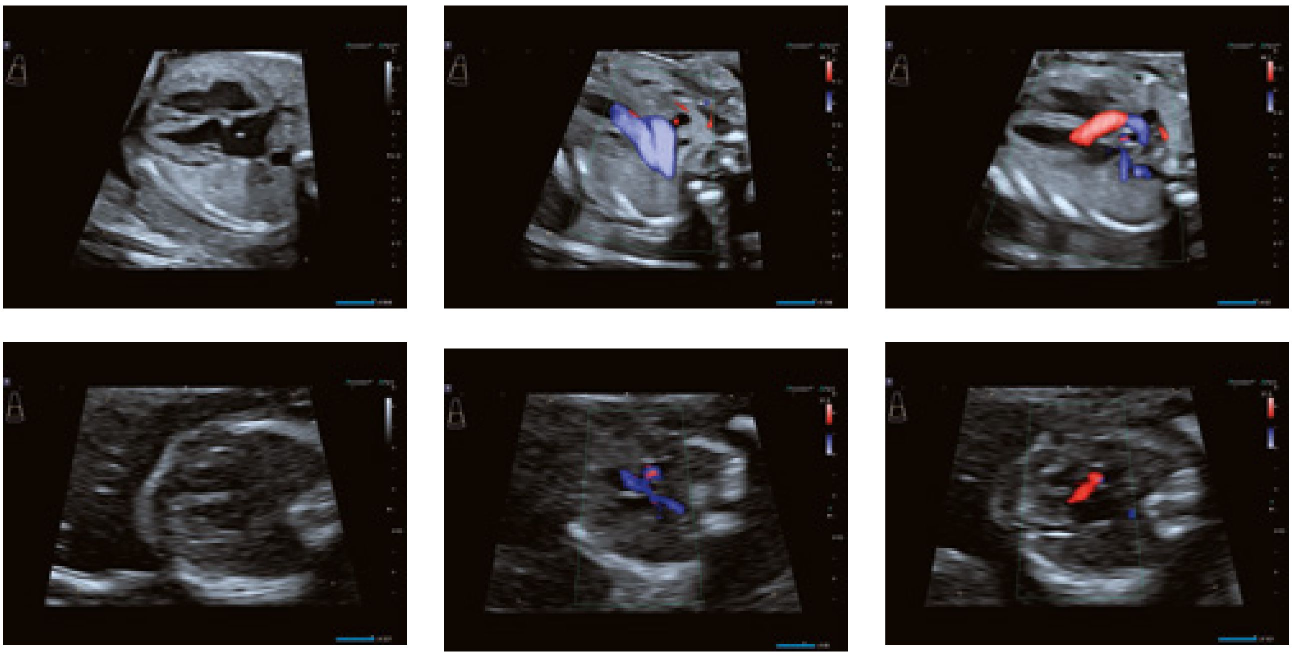
What range of services do you offer and what are the specific requirements for the ultrasound system used in your medical practice?
We are a large prenatal center serving the Kiel area and large parts of Schleswig-Holstein, in Germany. We offer extended first-trimester screening and heart diagnostics using echocardiography, and our service also includes invasive prenatal diagnostic methods. My colleague and I carry out around 4,000 ultrasound scans every year, including high risk screening.

Early heartdiagnostics play a particularly important role for us, as we can clearly see and examine the great vessels at this early stage and detect or rule out many possible malformations.

Diagnoses that we could previously not make until the 22nd week of pregnancy are now possible from as early as the 12th or 13th week, even though the heart is only the size of a grain of corn. Heart diagnostics is both the key discipline and a quality criterion here, as it distinguishes us from normal gynecologists.

Are there any particular challenges in your daily medical practice?
People are gaining weight; this is an insidious process and we are also noticing its effects. The tremendous amount of obese patients and the proportion of women who are difficult to scan is significantly increasing.

As the years go by, we are 'battling' more and more with a high BMI, especially in very young women. However, this has also been seen in part of the general increase in BMI in the German population.



Comparison of BMI of 60 and normal BMI of 21.

How does this affect the scans you carry out every day?
They take significantly longer, as the image quality is worse, and on average it takes longer to assess all the structures. On the other hand, the poorer image quality also restricts the accuracy of the clinical diagnosis. If conditions are very poor, it may even be impossible to carry out a proper assessment of certain organs, such as the heart.

I recently had a patient with a BMI of 60 (173 cm and 182 kg). But that is an extreme case, of course. Unfortunately, I had to tell the patient that even the latest technology had reached its limits here, and I simply could not safely rule out certain malformations, as I can otherwise do in 'normal' cases. So, it is definitely becoming increasingly important in the future for ultrasound equipment to handle these more difficult conditions.

Such a situation where I can not detect something because the ultrasound waves cannot penetrate deep enough into the abdomen is nowadays for me very rare. If I select the appropriate matrix transducer and a low frequency for a high penetration in obese women, it is possible to obtain excellent images despite the adverse conditions.

Vaginal scanning is a good alternative in overweight women for a successful first-trimester screening. Also for patients who are difficult to scan, because their uterus is retroverted, so that we cannot get the correct plane, the extremely high-resolution 3D vaginal transducer helps.

What is your opinion of the image quality of the Aplio i800?
The B-mode image is crucial in everyday life for our clinical diagnosis. In this context, the Aplio™ i800 is my first choice and I cannot imagine that anything else could be better. Also the quality of the color is amazing; the vessels can be shown in fine detail, even in first-trimester screening. The Advanced Dynamic Flow Doppler technique optimizes the spatial resolution and I can detect even the smallest vessels and flow patterns with precision, so my heart diagnosis is exact.

Did you find it difficult to switch to the Aplio i800?
I was committed to GE for the previous 15 years and was pleasantly surprised at the speed of the changeover. The Aplio i800 is intuitive and easy to use; once a certain length of time has passed, we can work blind. That saves time and I can concentrate on the image and nothing else. Next to the image quality, the ease of handling was our most important criterion. The workflow with the Aplio i800 is very good. Some additional features and presets that have been programmed save us time – and time is an important economic factor for us.

Would you recommend the Aplio i800?
I would definitely recommend the device for specialized prenatal diagnostics, because of its excellent B-mode images and the top quality of the color Doppler scanning.

The 3D quality is perfectly acceptable for surface rendering and is capable of producing an image of the fetus's face as a service for the patient. As most of our work uses cross-sectional imaging, the 3D quality was not an exclusion criterion for us. //

Dr Stefan Völckers
Joint medical practice abts+partner

About abts+partner:
- *Dr. Stefan Völckers and a number of other colleagues established the joint medical practice abts+partner, which currently have more than 100 employees at ten practice locations in Schleswig-Holstein,Germany,. Dr Stefan Völckers is in charge of prenatal care and prenatal medicine.*
- *The goal of abts+partner is to link basic gynecological outpatient care with specialized further diagnostics and inpatient treatment.*

Interview with Dr Rolf Gebing, Medical Director of St. Vinzenz Hospital, Düsseldorf, and Senior Consultant in the Diagnostic Radiology Department.

The imaging of the coronary arteries is a dream

Dr. Rolf Gebing is the Medical Director of St. Vinzenz Hospital, Düsseldorf, in Germany, and Senior Consultant in the Diagnostic Radiology Department. He works with Germany's first ever Aquilion Prime SP from Canon Medical Systems. Regardless of whether he is carrying out an ultra-low-dose pulmonary CT, cardiac CT, trauma spiral CT, CT-guided pain therapy, or perfusion CT, one thing is the same: "with the high-performance CT, we are 100 percent present on the market and are able to get involved in any area", explains Dr. Gebing in an interview.

Dr. Gebing, you are the Medical Director at St. Vinzenz Hospital, the first center for musculoskeletal medicine in Düsseldorf. Please could you briefly describe your range of expertise and your focal areas?
Our orthopedic department is a renowned clinic specializing in joint operations, an endoprosthetic center for maximum treatment and significantly involved in the provision of treatment in the Düsseldorf region. The spinal surgery that we offer is carried out in one of the largest surgical centers of its kind in North Rhine-Westphalia. The Center for Internal Medicine and Surgery with its jointly managed Abdominal Center (Marien Hospital) is another major specialism of the Vinzenz Hospital.

Why did you recently opt for the new CT Aquilion Prime SP? And what were your expectations of the new CT system?
For us, the Aquilion™ Prime SP is an investment in the future. We needed a CT that we could use to do almost anything. We are investing in the Vinzenz Hospital site here and are constantly growing: our Marienkrankenhaus in Düsseldorf-Kaiserswerth, which also forms part of the group; the entire traumatology sector of the group will be transferred to us. In order for this to be possible, there are plans to set up a large new surgical wing at St. Vinzenz Hospital by the end of the year. What is more, there are plans for the geriatric medicine department of our Elbroich Hospital, specializing in psychiatric and acute geriatric diseases, to also be transferred to us over the next three years. We will then be carrying out even more brain perfusion scans, angio-CT examinations and trauma spiral CTs. A hospital with this configuration requires a high-end CT system, which must be suitable for use in both outpatient and inpatient care in all respects. This is why we opted for the new Aquilion Prime SP. The facts that the medical council is constantly demanding further dose reductions and that we are reliant on quick turnaround also played a role in this decision. Dose reduction software is extremely important in this day and age, both for us and for the referring physician and patient. With the new low-dose CT, we are now in a strong position.

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Has it met your expectations? What are your experiences in terms of image quality and dose?
We can significantly reduce the radiation dose in all areas. This applies to preoperative CT examinations just as much as CT interventions. For example, in computer tomography-guided pain therapy, PRT, we have been able to reduce the dose by a factor of 4-5. The same also applies for bone marrow examination in the course of tumor treatment. With the new CT, CTs of the chest require a lower dose than conventional X-ray images and, due to the 3D dataset, they offer increased added value in diagnostics.

Chest CT with a lower dose than in a conventional X-ray, pain therapy with a dose that is only 20% of the previous dose

We are always significantly below the values required for the radiation dose by the medical council. At the same time, the entire team was amazed by the extremely good image quality from day one.

What examinations do you always carry out with the new CT?
So, our range of applications is extremely complex. We offer all examinations except for PET scans. For example, when replacing vertebrae we can accurately detect the course of the vessel when positioning the screws. We can pinpoint the cover of bone to vessel. This allows us to carry out highly individual pre-operative care and planning.

More so than the primary installation, the Aquilion Prime SP plays a major role when exchanging endoprostheses. We use approximately 1,000 prostheses a year in our endoprosthesis center. By suppressing the metal artefacts using SEMAR technology, we can detect fissures, fractures and other complications much more easily and reliably and carry out a significantly better periprosthetic in-depth analysis. If we need to assess endoprostheses, we can also carry out rotation angle measurements on the knee.

1000 prostheses are used here every year, meaning SEMAR metal artefact reduction offers significant benefits

We are able to analyse the intervertebral disc implants and the screws used in spinal surgery in detail. In the event of tumorous diseases, we can accurately identify the extent of progression and therefore carry out optimal surgical planning.

Has the Aquilion Prime SP changed the scope of your work? What examinations have been newly added?
The Aquilion Prime SP doesn't limit us at all. We can offer the entire range of services. With the new CT, precise images of the coronary arteries can be taken with a minimum dose here at our hospital for the first time. In the event of acute chest pain, aortic dissection can be diagnosed. We can now go full speed with the Triple-Rule-Out (TRO) protocol and thus capture the entire chest cavity in a scan procedure, getting a triple report for the heart, lungs and aorta. What is more, we no longer need to make compromises when carrying out trauma spiral CTs, as these will be carried out in accordance with the requirements of a trauma centre here. Furthermore, our pulmonary embolism diagnostics have considerably improved thanks to the subtraction software: even smaller embolisms can now be easily detected.

Workflow improvements thanks to the reconstruction speed

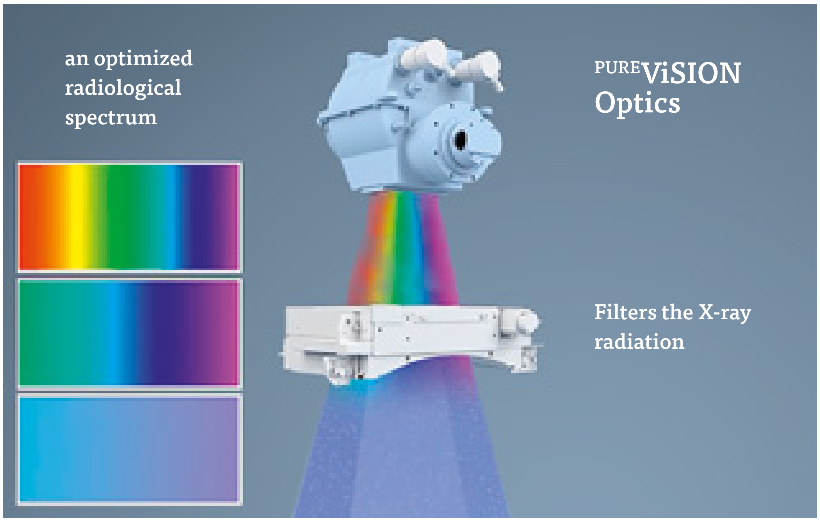
How do you assess the speed, the rapid reconstruction of the images?
When we carried out the first abdominal scan, my team and I were extremely impressed with the speed.

Dr. Rolf Gebing.

It was so quick that we had to adapt the application of contrast medium accordingly. This is, of course, a major advantage, especially for the patient. As we were already familiar with the surface modalities, we did not need to change our ways, but could begin with the clinical routine immediately. As a hospital, we are under pressure to offer everything in the shortest amount of time possible. Nobody here wants to wait for radiology results. With the Aquilion Prime SP we can fulfil these expectations.

Does this mean that your decision to opt for the Aquilion Prime SP was the right one and that you feel this has been confirmed in retrospect?

Definitely, yes. With the high-performance CT, we are 100 percent present on the market and are able to get involved in any area and answer any questions that arise. Even the imaging of the coronary arteries is a dream. Thanks to brilliant technology and the amazing people in my team, we are able to assess a number of complex and unclear cases and carry on enjoying experimenting within our specialist area. //



Aquilion Prime SP with new PUREViSION Optics

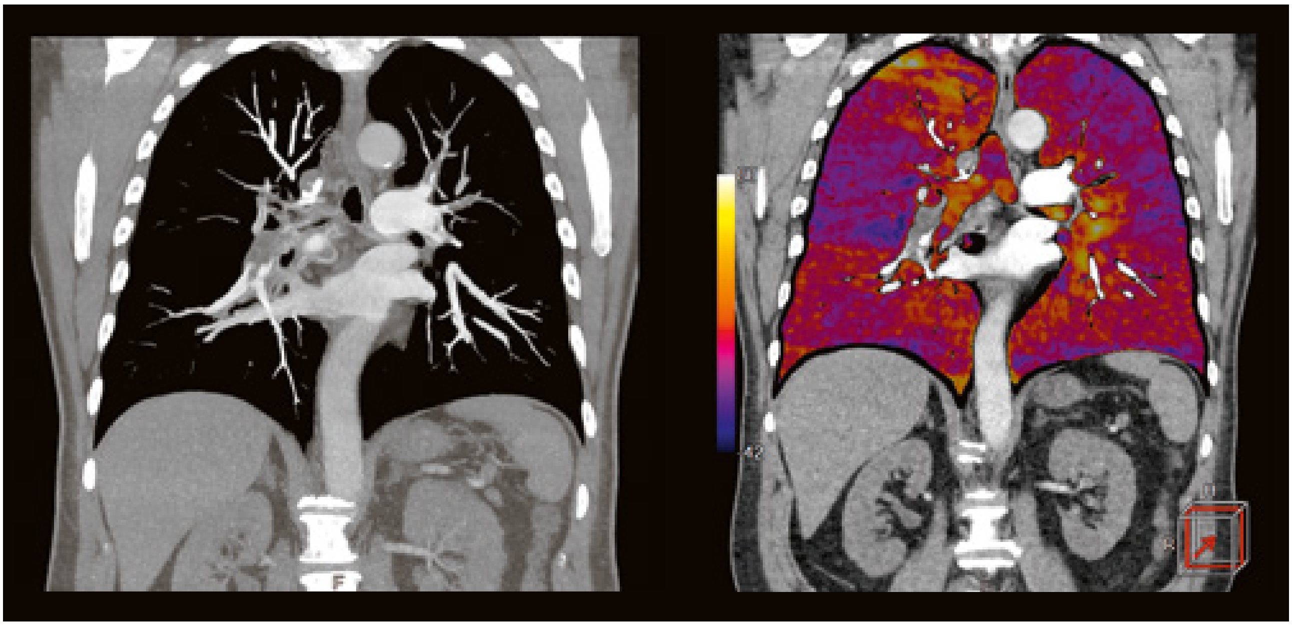
The Aquilion Prime SP (Superior Performance) was exhibited for the first time in Europe at the ECR 2018 in Vienna by Canon Medical Systems. The new low-dose 80-row CT combines high-quality imaging with the lowest dose, while at the same time, offering maximum efficiency.

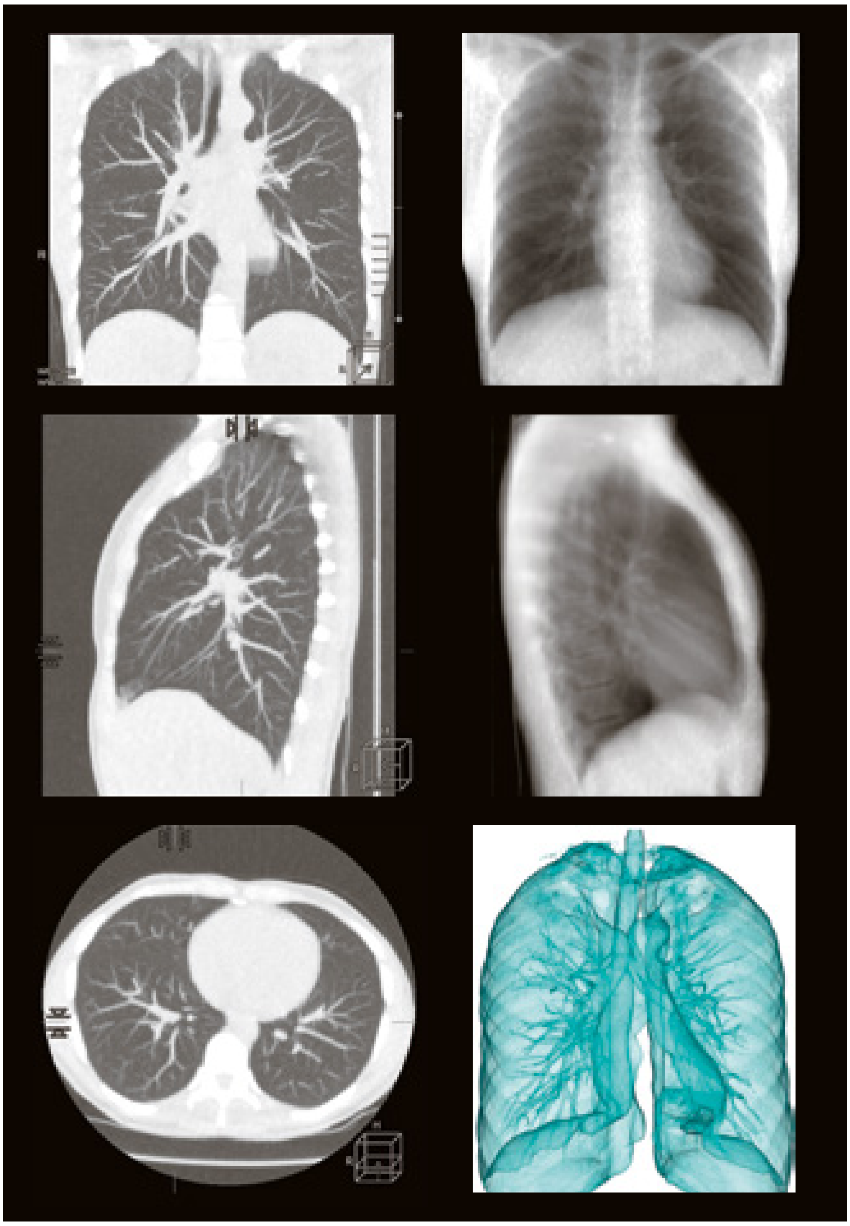
Integral components include the new PUREViSION Optics and the PUREViSION Detector, which further improve the image quality considerably. The new PUREViSION Optics filters the X-ray radiation and optimizes the beam spectrum; a more homogeneous distribution visibly improves the image quality, which particularly benefits the low-contrast imaging.

What is more, the new Aquilion Prime SP was fitted with new reconstruction hardware, which reconstructs up to 50 (70 opt.) images per second, incl. the iterative dose reduction AIDR 3D, which works in raw data and image data.

Aquilion Prime SP cases of Dr Gebing:

Case 1:
Lung subtraction to investigate a pulmonary embolism CTDI 5.2 mGy, DLP 250 mGy*cm



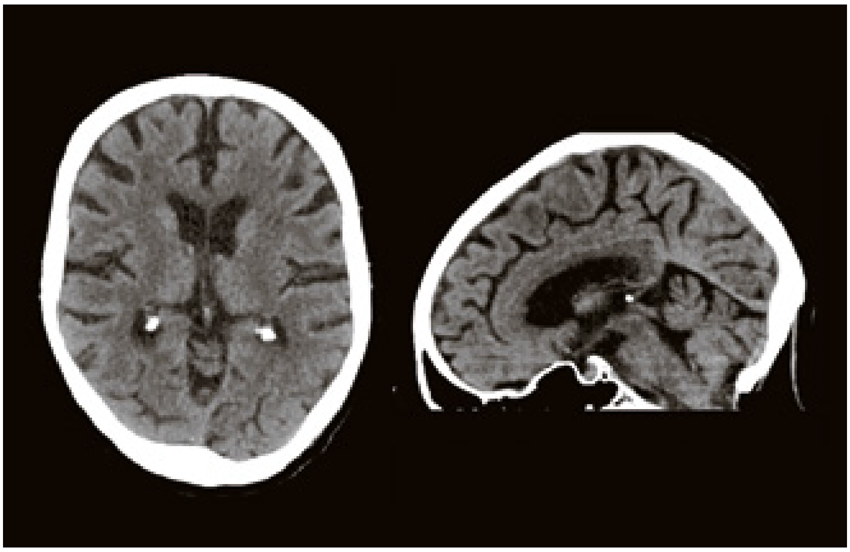


Case 2:
Ultra-low-dose lung with 0.02 mSv eff. dose

Scan protocol:

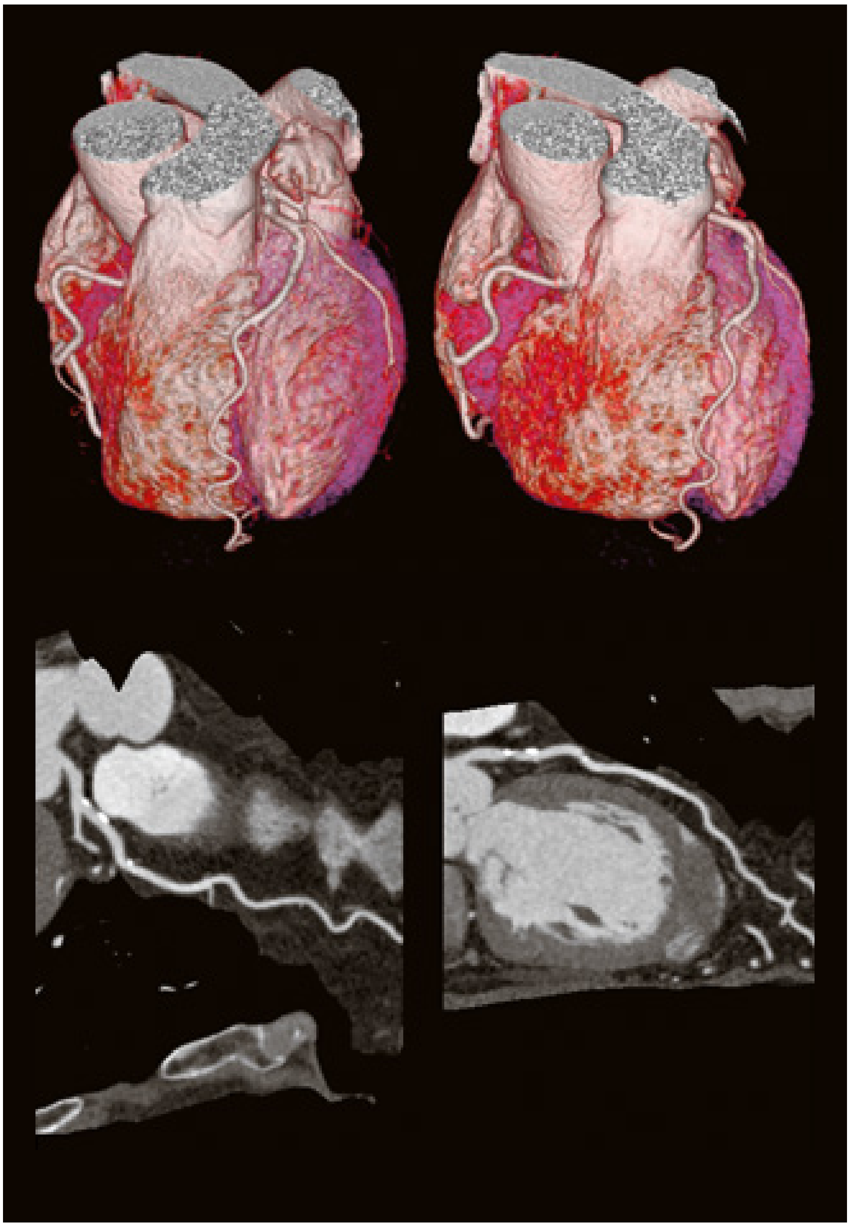
Collimated light 40 mm, 0.35 sec./rotation, pitch 0.9, 80 kV, 10 mA, 3.5 mAs AIDR 3D Standard and PUREViSION Optics, Kernel FC01
*DLP 1.7 mGy*cm, eff. dose 0.02 mSv*

For comparison:
effective dose of a chest X-ray image:
0.01 - 0.03 mSv (per image!)
Source: Bundesamt für Strahlenschutz [Federal Office for Radiation Protection] https://www.bfs.de/DE/themen/ion/strahlenschutz/grenzwerte/grenzwerte.html



Case 3:
Plain CT of the brain, CTDI: 39 mGy; DLP: 738 mGy*cm, 1.5 mSv

(35 percent below the Federal Office for Radiation Protection's diagnostic reference value for 2016 of 60 mGy.)



Case 4:
Low-Dose-Cardio-CT, scanned with SURECardio Prospective, CTDI 9.6 mGy, DLP: 127 mGy*cm, eff. dose 1.8 mSv

(52 percent below the Federal Office for Radiation Protection's diagnostic reference value for 2016 of 20 mGy for a prospective ECG-triggered coronary angiography.)

Case 5:
Pelvic-leg angiography CTDI: 5.8 mGy, DLP 760 mGy*cm

(27 percent below the Federal Office for Radiation Protection's maximum diagnostic reference value for 2016 of 8 mGy for a CT-angiography of the pelvis/leg.)

VKKD:

- *The St Vinzenz Hospital is part of the Verbund Katholischer Kliniken in Düsseldorf [Composite Catholic Clinics Düsseldorf]. The VKKD runs five hospitals, a rehabilitation clinic and a home for sick elderly people with approx. 1,600 beds.*
- *In addition to St. Vinzenz Hospital, the Augusta Hospital, the Elbroich Hospital, the Marienkrankenhaus Kaiserswert, the Marien Hospital Düsseldorf, the St. Mauritius Treatment Hospital and the Katharina Laboure Home for Sick, Elderly People also form part of the VKKD.*
- *Dr Rolf Gebing is Medical Director of the St. Vinzenz Hospital, Senior Consultant in the Diagnostic Radiology Department and Specialist in Diagnostic Radiology.*

The new member of the Vantage family: Vantage Orian 1.5T Premium MRI

Canon Medical has presented its first MRI system since it changed its name (formerly Toshiba Medical), the Vantage Orian 1.5T, at the ECR 2018 congress in Vienna as a world première. The Vantage Orian is the only system that meets every need: It features high energy-efficiency in daily clinical practice, proves impressively reliable, builds clinical confidence, and it boasts superior patient comfort to boot.

In connection with the innovative and workflow-oriented Magnetic Resonance post-processing solutions by Olea Medical, a subsidiary of Canon Medical Systems, the Vantage Orian™ offers everything, from daily routine to research applications. Since May this year, the software Olea Vision will be provided with each Canon Medical's MRI system. Olea's newest development is a post-processing package for magnetic resonance mammography analysis and biopsy planning.

Vantage Orian 1.5T Premium MRI.

High energy-efficiency

High energy-efficiency in MRI and MR examinations is achieved at various: The hardware, which is designed for efficient installation and energy-efficient operation, is one aspect of this. In addition, examinations should take place with minimal effort for all patients and lead to the highest-quality results thanks to rapid, state-of-the-art sequences.

The minimum installation area of 25 m² (if necessary, without the additional technical room) enables space-saving installation. The new two-step technology of Eco Mode and Eco Mode Plus are basic technological features of the Vantage Orian. The first step of the Eco Mode is activated with a change of patient and the second step, when the MRI is idle, such as at night. With the Eco Mode Plus, energy consumption of the cold head is decreased by a solid one-third.

High energy-efficiency during examinations is achieved thanks to the use of lightweight, combinable matrix coils and automated examination sequences. Depending upon clinical need, there is also a detachable patient couch available for examining patients efficiently with the least possible amount of awkward repositioning. The latest fast scan technologies, such as MultiBand SPEEDER™, QuickStar, mVox Fast 3D, K-t-SPEEDER and Olea Nova+® are breaking through the past limitations of examination limitations of examination procedures.

ForeSee View increases the efficiency of every planning, because an anatomical preview of the slice to be planned is displayed. As part of continuous refinement of automated planning assistants, Canon Medical now additionally offers Knee Line and Sure VOI to improve the efficiency and comparability of knee images.

- MultiBand SPEEDER is a technology used to acquire multiple slices at the same time by using simultaneous multiband excitation RF pulses. Measuring time can often be reduced by half. This technology is especially suited for large-volume diffusion and DTI examinations.
- QuickStar offers free-breathing images, which reduce motion artefacts. This technology can be used for the whole body, including hepatic- and cardiac imaging. The star-shaped readout of the K-space, for example, also reduces susceptibility artefacts.

- mVox Fast 3D can be used for brain exams. The technology drastically reduces exam time and yields a high-resolution image with improved corticomedullary differentiation. This T-1-weighted technology shows enhanced structures more clearly without superimposition of small vessels compared to the MP-RAGE technology.

- ForeSee-View technology offers uniquely effective planning assistance, thereby clearly reducing planning time. After an overview image has been displayed, a real-time preview window is opened and the planning result displayed as Live MPR to prevent bad planning. This function is available for all scan regions.

- K-t-SPEEDER for cardiac MRI is an innovative tool for the acquisition of free-breathing cine images. This technology automatically adjusts to the patient's circumstances, which also makes the exam easier for the person performing it.

- Olea Nova + is used to produce other tissue contrasts synthetically from two acquired sequences that can be used for diagnostics. A T1 and T2 map with absolute values is created. For example, image contrasts with long or very short TE can be calculated; TR or TI can be extended, as required, even if the patient is no longer in the scanner.

Best patient comfort

Vantage Orian offers optimal patient comfort during the entire examination. With its 71 cm patient opening and height-adjustable table, it is the ideal system for performing an MRI exam, even for bariatric and claustrophobic patients. Canon Medical Systems also offers patients with claustrophobia an incomparable experience with MR Theatre. MR Theatre can also used when examining small children to keep them still without sedation; videos can be played to entertain them during functional MRI.

MR Theatre is a unique way of removing the feeling of claustrophobia, because it is already active when the patient is placed into the MRI scanner. During the exam, the unique noise-reducing Pianissimo technology then deploys its effect.

The acoustically active decoupled gradients are much quieter than other gradient systems, without any loss of efficiency for the sequences. The virtually silent Pianissimo ZEN technologies are also available with the Vantage Orian. The volume of Pianissimo ZEN sequences is only <2 dB greater than the ambient volume level. In paediatrics especially, this option also offers protection from noise, a fast exam procedure and happy physicians and parents.

Free-breathing images can be taken in combination with the QuickStar sequences mentioned above and Navigator-triggered sequences. By using one or even two detachable patient table(s), patients can have the procedure explained to them in a comfortable position and relaxed atmosphere. Of course, the table also has a guardrail and various positioning aids.

Clinical confidence

To achieve confidence in the clinical results of an MR system, a good and consistent image quality has to be achieved, and state-of-the-art examination technologies must be available. The prerequisite for this is excellent hardware with three main components: magnet, gradient and RF components. Canon Medical's Zero Boil-Off Magnet features excellent homogeneity even for large FOV.

Thanks to the new, high-pressure-produced slim gradients, which are cooled in three sections and its high gradient strength (up to 45 mT/m amplitude and up to 200 mT/m/ms slew rate), new standards in measuring time and reduction of motion artefacts can be achieved, in particular in neurological- and cardiological imaging. At the same time, image sharpness is increased, especially for demanding sequences. High-resolution WFS-FSE sequences (Dixon) in all body areas benefit from this, for example. WFS technology ensures homogeneous fat suppression, even in large areas and inhomogeneous areas, thereby increasing diagnostic certainty.

The PureRF technology with up to 38% improvement in SNR is a technological feature of the new Vantage Orian. PureRF Rx works similarly to noise cancellation in headphones; electrical noise is detected and reduced during digitalisation of the signal. This technology offers full digitalisation of the signal by means of independent AD converters, to make best use of the 128 RF channels and ensure processing is as efficient as possible.

- With four image contrasts (in-phase, out-of-phase, fat and water), WFS FSE offers a sequence with the highest resolution and reduces measuring time compared to individual images. It is available for all regions of the body. This sequence is also suitable for imaging after contrast medium (CM) administration. Canon Medical's water-fat separation technique is a modified Dixon technique.

Clinical confidence is achieved through excellent MR images. The Canon MR Image Gallery provides several examples of the technologies mentioned above for each clinical discipline: neurology, oncology, musculoskeletal sports medicine, cardiology and vascular diagnostics.

Clinical analysis of the image data can be performed with the operating console, or a separate MRI console that is equipped with Olea Medical instruments. The Olea Vision, as a second console, is always provided with a Canon Medical MRI system. Various clinical solutions are available for the clinical disciplines in question: neurology, oncology, musculoskeletal sports medicine, cardiology and vascular diagnostics. //

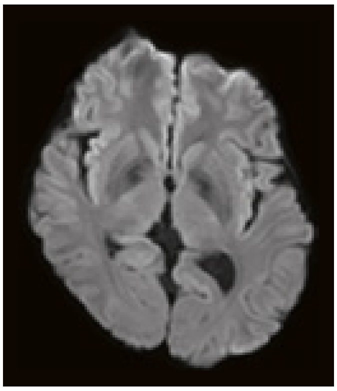
Olea Sphere – clinical analysis by Olea Medical – a subsidiary of Canon Medical.

FAST	Fast: 45 mT/m and 200 T/m/s, detachable table, innovative sequences
71cm	Patient-friendly: 71 cm patient opening, Pianissimo and Pianissimo ZEN, MR Theatre
IQ	Clever: PureRF, MultiBand SPEEDER, ForeSee View, QuickStar, Olea Nova+®, Dixon WFS FSE and much more.
25m²	Economical: 25 m², 2-step Eco Mode, no additional technical room

Image Gallery

Neurology:

1. Volume DWI

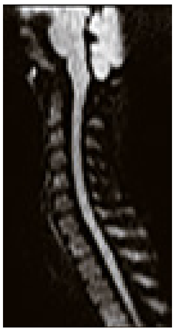


b = 1,000
Scan time with multiband 2: 4:24 min.
Resolution: 0.7 x 0.7 x 3 mm
Measuring time reduced from 8:12 to 4:24 min by using MultiBand SPEEDER technology.

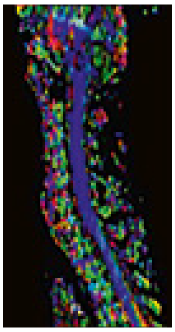
2. Emergency cervical spine protocol in just six minutes' scan time

T2WI
65 sec.

T1WI
51 sec.



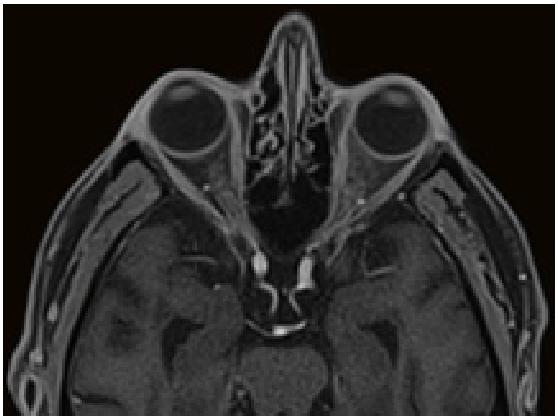
DWI b= 800
108 sec.



FA (fractional anisotropy) map

T2*WI
132 sec.

3. Orbita with QuickStar for reducing susceptibility artefacts



Axial FFE 3D QuickStar including MPR resolution: 0.9 x 0.9 x 1 mm
Scan time: 3:24 min.

Radiology applied in MSK Sports Medicine:

1. Meniscus and cartilage images in the knee

PD FSE 2D, resolution: 0.4 x 0.3 x 2 mm

2. Talocrural joint in high-resolution, WFS-FSE T1 with CM

Sagittal T1 post-CM water image and in-phase
Resolution: 0.6 x 0.7 x 2.5 mm
Scan time: 4:24 min.

Cor T1 post-CM water image and in-phase
Resolution: 0.6 x 0.7 x 2 mm
Scan time: 4:50 min.

Axial T1 post-CM water image and in-phase
Resolution: 0.7 x 0.5 x 3 mm
Scan time: 3:20 min.

With the kind assistance of Kanta-Hameen Keskussairaala, Finland.

Oncology:

1. Use of the WFS Dixon method for the whole spinal column; automated stitching of multiple levels

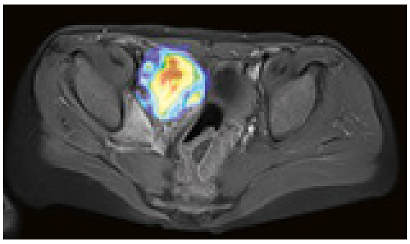
Sagitall T1 in-phase

Sagitall T1 water image

WFS Dixon T1W FSE post-CM administration
Resolution: 1.2 x 1.2 x 3 mm
Scan time: 2:30 min. x 2 levels

Courtesy of Dr. Arakawa, Saiseikai Kumaoto Hospital, Japan.

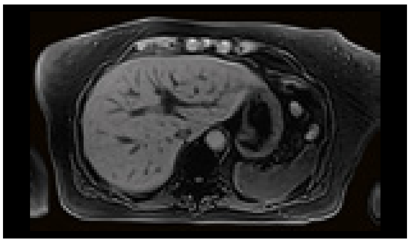
2. Tumor change: WFS Dixon, DWI and image fusion, stitching of multiple levels



Fusion axial T1 water image post-CM and axial DWI
resolution: 1.1 x 0.7 x 4 mm
Scan time: 4:04 min.

Courtesy of Dr. Herman Kan, Texas Children's Hospital, USA.

3. QuickStar, liver in free-breathing



Axial FE3D T1 fat-sat QuickStar resolution: 1.6 x 1.6 x 2 mm
Scan time: 3:32 min.

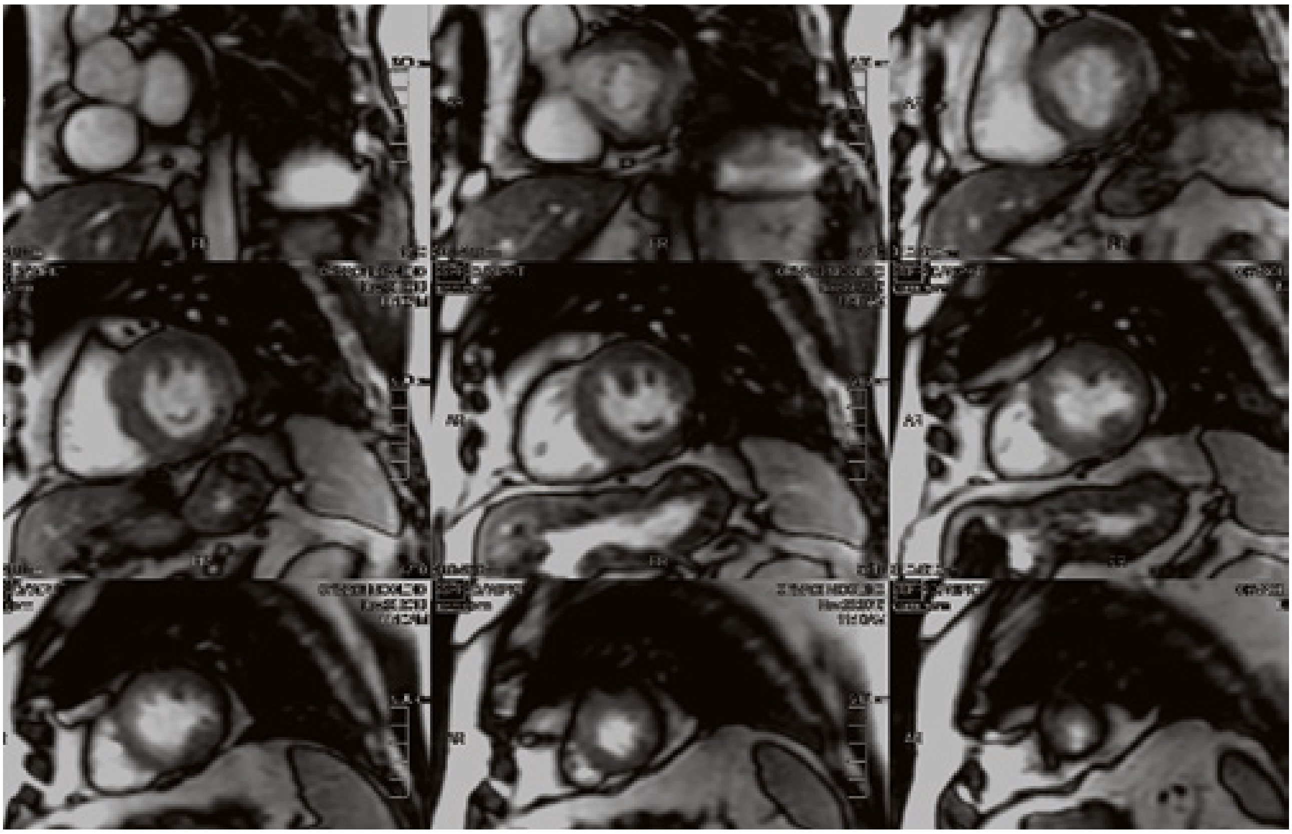
Courtesy of Dr. Alomar, Clinica Creu Blanca, Spain.

Cardiology:

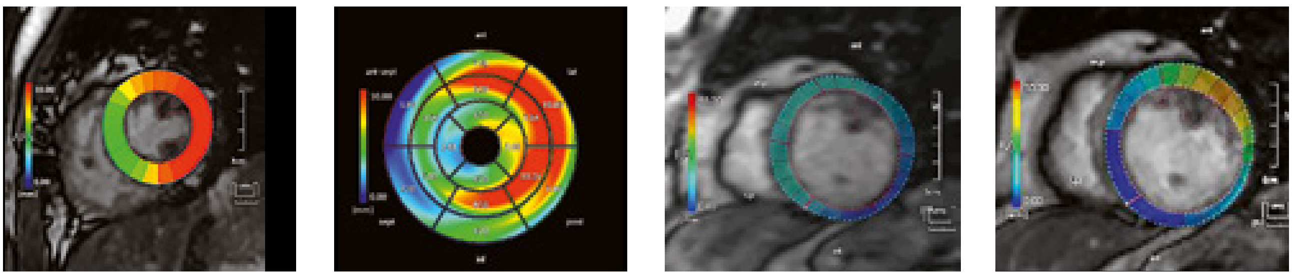
1. Short axis cine imaging with K-t-SPEEDER:

SA 2DSSFP cine Kt SPEEDER 4
6 sec./slice

Cardio images: With the kind permission of InCor, Brazil.



SA 2DSSFP cine
Complete coverage with cine imaging KtSPEEDER 8 in free-breathing.

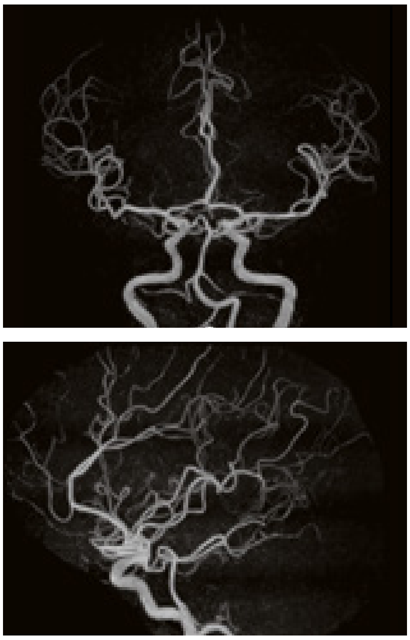


Cine imaging KtSPEEDER in free-breathing – post-processing with Canon MR Wall Motion Tracking on Vitrea Workstation.

With the kind permission of InCor, Brazil.

Vascular Diagnosis:

1. TOF angiography without CM administration

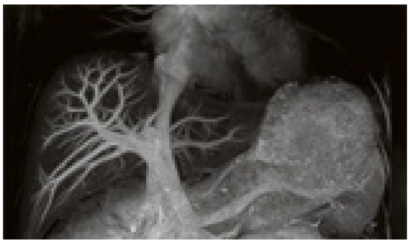


Axial 3D TOF
Resolution: 0.9 x 0.6 x 0.5 mm

2. FBI (Fresh Blood Imaging) – Iliofemoral angiography without CM administration

Co FBI
Scan time: 2:47 min. x 3 levels

3. T-SLIP images (without contrast medium) of abdominal vessels



Co TSLIP SSFP 3D.

Functional imaging of the liver vessels without CM administration with Co TSLIP 3D.

Canon
CANON MEDICAL

Technology for the Future of Medical Imaging

Canon Medical, leader in diagnostic imaging systems, advanced visualization, and health informatics, reinforces its commitment to the advancement of medical imaging and healthcare by accelerating its R&D program in the deep-learning space.

Pioneering technology, clinical research, and collaborative partnerships have always been the basis of our path to innovative solutions that improve clinical decision making at every step of patient care. Our most recent examples using deep learning range from reconstruction technologies and advanced applications for our imaging systems to smart algorithms in healthcare informatics.

Canon Medical and NVIDIA entered a partnership in Japan, targeting co-development of deep-learning infrastructure for medical research institutions, and enabling further research on the application of deep learning for early detection and diagnostic support systems. In Europe, Canon Medical established the AI Center of Excellence to support collaborative research with top-tier academic and government organizations.

A novel microvascular flow imaging technique for the evaluation of fetal and placental circulation

Dr Junichi Hasegawa

Doppler imaging is commonly used for the assessment of fetal and placental circulation. Nevertheless, conventional Doppler techniques have a limitation in visualizing low-velocity blood flow in minute vessels due to motion artifacts caused by respiratory motion and fetal movement. A novel microvascular flow imaging technique, Superb Micro-vascular Imaging (SMI), provides extraordinary sensitivity in visualizing low-velocity blood flow, while suppressing artifacts and maintaining high resolution and high frame rates. With these features, SMI allows a more detailed evaluation of the fetus and placenta, compared to conventional Doppler technologies.

Suppression of motion artifacts

One of the major difficulties in obstetric ultrasonography is to overcome the motion artifacts generated by respiratory motion, maternal aortic pulsation, and normal fetal movements during the examination. Reduction of motion artifact is important in all ultrasound examinations, but has additional challenges in Obstetrics.

SMI analyzes clutter motion and uses a new adaptive algorithm to identify and remove tissue motion in order to reveal lowvelocity blood flow in minute vessels. With this significant reduction of motion artifacts, prenatal diagnosis can be done faster and more easily. SMI operates in two modes: monochrome SMI (mSMI), which subtracts the background images for more focus on detailed vasculature, and color-coded SMI (cSMI), showing flow components in color on top of the grayscale B-mode image at a high frame rate.

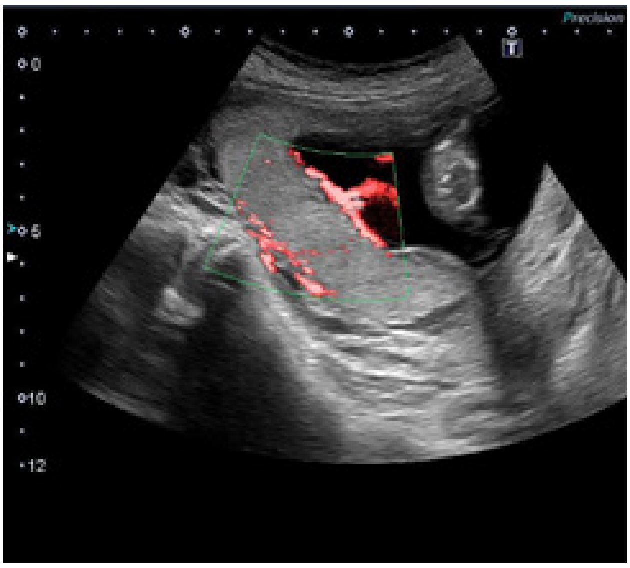


Figure 1: Despite the motion artifacts generated from maternal respiratory motion, cSMI could clearly depict the lowvelocity vessels in the placenta (Frame rate = 54 fps).

Early prenatal diagnosis

Early detection of fetal abnormalities is critical in obstetrics. In early gestation, the organs of the fetus are small and contain low blood flow. Clinicians therefore require high-definition B-mode images for morphological evaluation, and Doppler technologies to depict low velocity blood flow in minute vessels for functional analysis. Despite fetal movement, SMI can be used to obtain high resolution Doppler images at high frame rates and reveal minute vessels, such as abdominal vessels, the pulmonary vein and the intracranial vascularity.

Evaluation of placenta

SMI is useful for the evaluation of functional development and pathophysiology of the placenta.

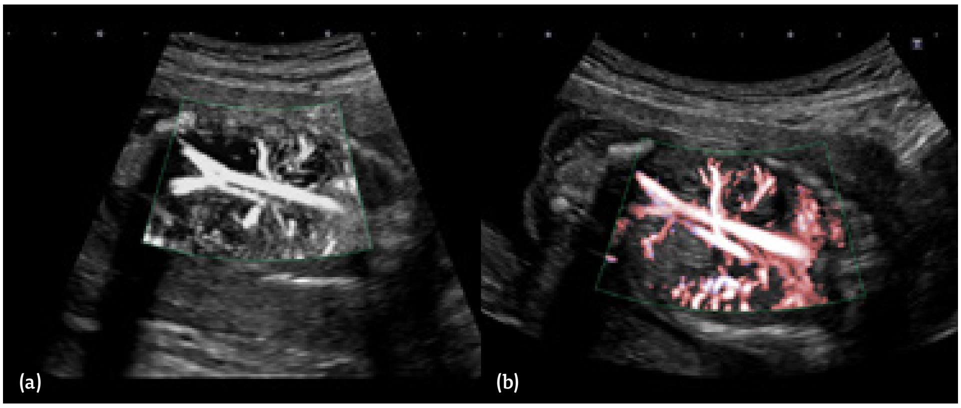


Figure 2: Abdominal vasculature at 19 weeks (a) mSMI (b) cSMI.

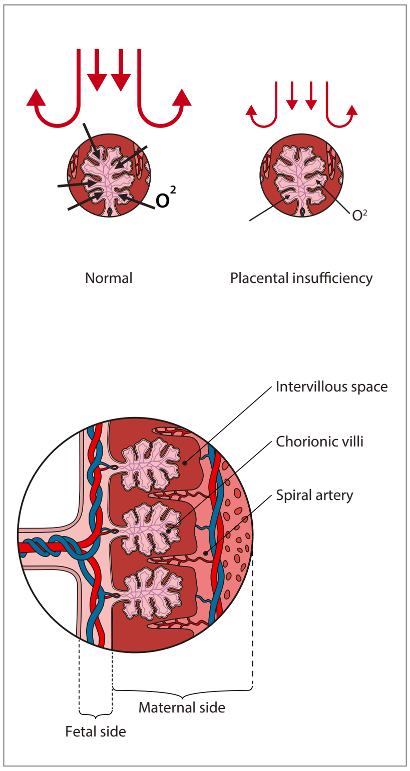


Figure 3: Anatomy of placenta.

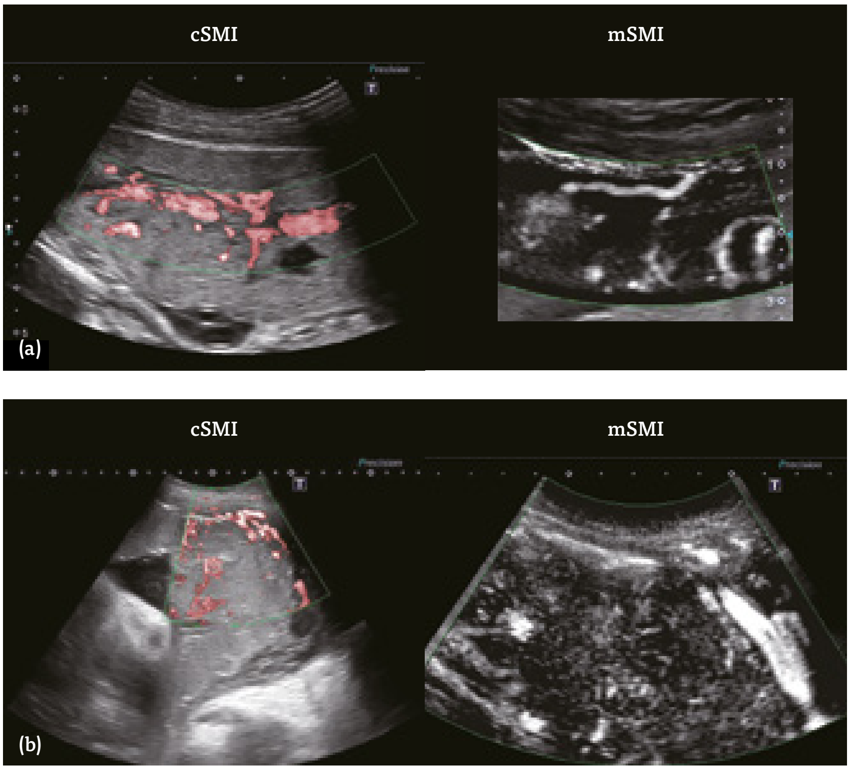


Figure 4: Delineation of placenta with SMI (a) Basal plate (maternal surface) (b) Chorionic plate (fetal surface).

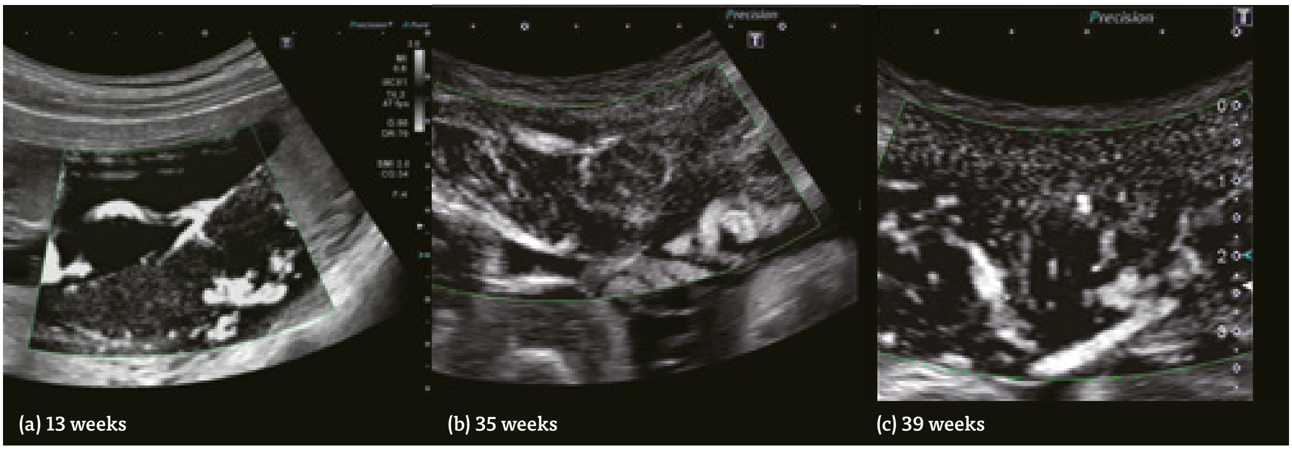


Figure 5: Development of the placenta visualized by mSMI.

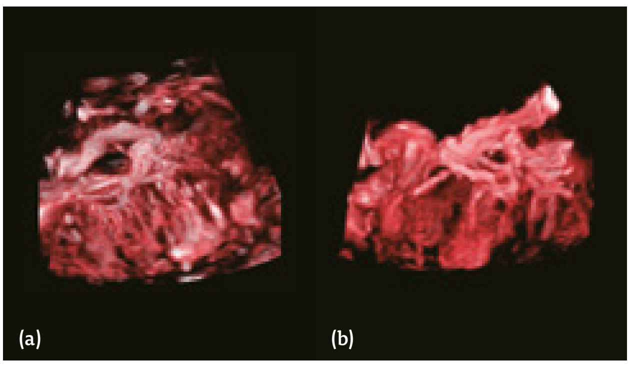


Figure 6: 3D reconstruction of placenta using Smart Sensor 3D with SMI (a) 14 weeks (b) 30 weeks.

In Fig. 4, SMI clearly depicted the villous capillaries at the chorionic plate as well as the maternal blood vessels at the basal plate, indicating the region of intervillous space.

In addition, during examination of placental growth with increasing gestational age, SMI is capable of delineating the reduction of villous capillaries within the terminal villi caused by placental insufficiency (Fig. 5).

Combining SMI with Smart 3D allows visualization of the entire vasculature in 3D. This volume is reconstructed from images acquired by free-hand scanning using conventional 2D transducers. Utilizing these two tools for placental assessment, the increased villous capillary growth and branching with placental maturation can be visualized (Fig. 6).

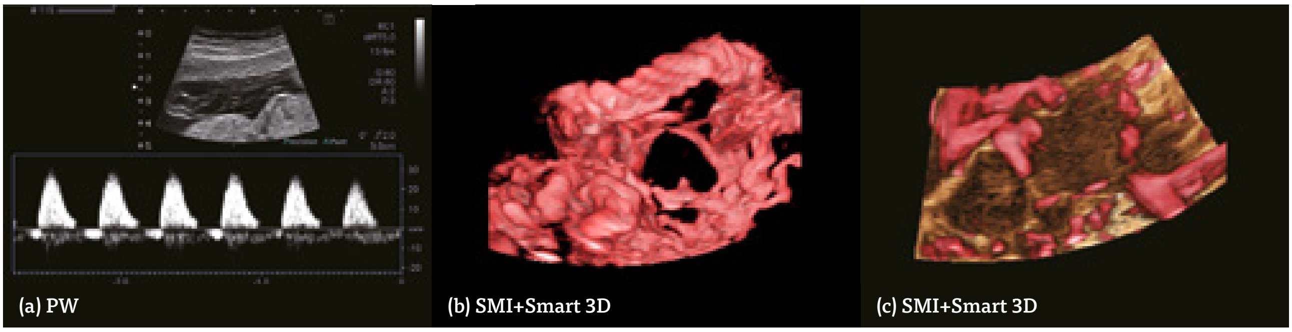


Figure 7: Placental insufficiency at 32 weeks (a) Pulse wave: arterial flow is low and resistance is high. (b, c) SMI with Smart 3D: Villous trees have decreased significantly in the placenta and branching vessels became congested.

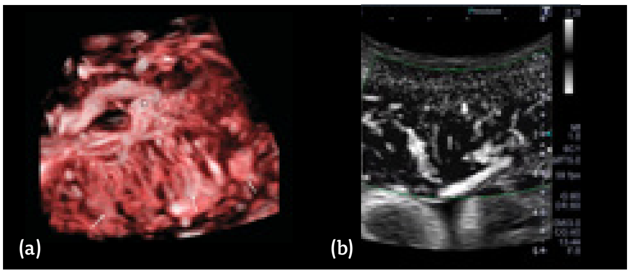


Figure 8: Spiral arteries using (a) SMI with smart 3D and (b) mSMI.

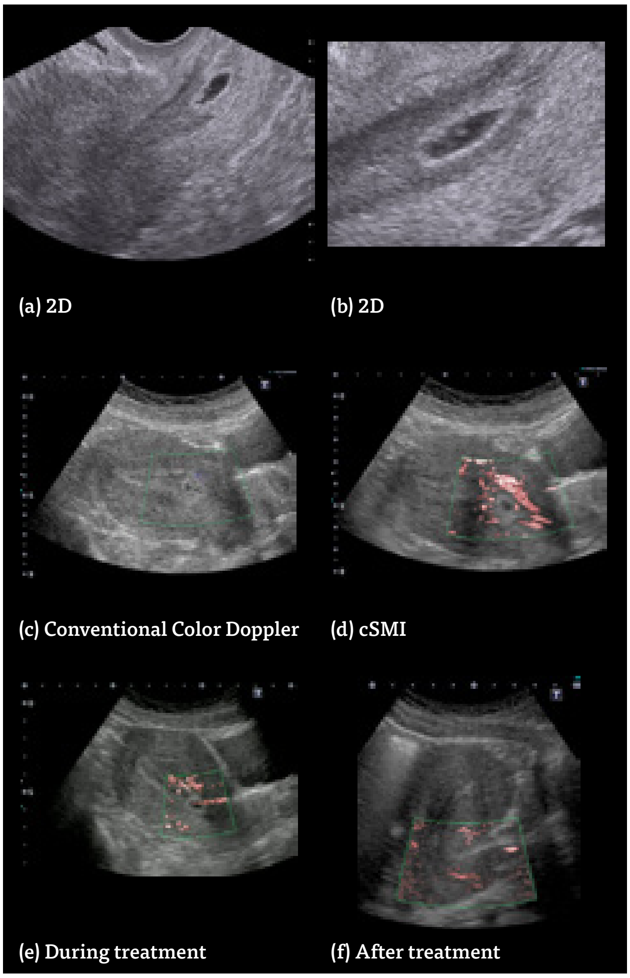


Figure 9.

Early morphological evaluation of the placenta can be performed with ease for early detection of placental infarction (Fig. 7). As a result, SMI has a great potential for early detection of placental insufficiency. Images with extraordinary resolution obtained with Aplio™ i-series also enable the examination of spiral arteries and branches of villous capillaries within the terminal villi (Fig. 8). This is not possible when using conventional Doppler technologies.

Evaluating fetoplacental function with conventional Doppler technologies enables clear visualization of main stem vessels; however, SMI is capable of visualizing the low velocity flow vessels at the peripheral placental villi and provide a full profile for fetoplacental function. Moreover, SMI has a high potential for evaluation of the methotrexate (MTX) treatment. In a case of cervical pregnancy (Fig. 9), MTX treatment was performed to induce termination. cSMI was able to visualize the decrease of vascular signal and confirm the treatment efficiency.

Conclusion

Superb Micro-vascular Imaging is a valuable tool for obstetricians. SMI can easily distinguish minute low velocity flow in the placenta by suppressing motion artifacts caused by respiratory motion, aortic pulsation from the mother, and fetal movement. Therefore, SMI has high potential for the evaluation of placental function including accurate grading which allows early detection of placental insufficiency. //

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St. Marianna University School of Medicine,
Kanagawa, Japan

Reference

[1] Hasegawa, J., Yamada, H., Kawasaki, E., Matsumoto, T., Takahashi, S., & Suzuki, N. (2017). Application of superb micro-vascular imaging (SMI) in obstetrics. The Journal of Maternal-Fetal & Neonatal Medicine, 1-6.

[2] Hasegawa, J., & Suzuki, N. (2016). SMI for imaging of placental infarction. Placenta, 47, 96-98.

[3] Nakazawa. H., Hasegawa, J.,Yoshioka, N., Honma, C., Takahashi, Y., Takeuchi, J., Ohara, T., Kondo, H., Tozawa, A., Sukuki, N., et al. (2017). A case report of uterine cervical pregnancy evaluated by Superb Micro-vascular Imaging. Japanese Journal of Medical Ultrasonics, 44(3), 283-287.

Acknowledgement

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Excellent B-Mode imaging and impressive color presentation

Prof. Dr. Martin Krapp is a specialist in prenatal medicine, focusing on fetal cardiology, at the amedes experts specialist medical center in Hamburg, Germany. He has been performing scans using the Aplio i800 from Canon Medical Systems since May 2017. In addition to the excellent B-mode image quality, he is particularly impressed by the fact that the ultrasound system delivers high-quality results in an extremely wide patient population, even in poor scanning conditions.

What range of services do you offer and what are the specific requirements for the ultrasound system used in your medical practice?
We are specialized in ultrasound diagnostics for patients with specific conditions. This means that we look after high risk patients when there are specific questions, or gynecological patients with specific abnormalities, identified during an ultrasound. The next step here is ruling out malformations. For this we need the best ultrasound equipment on the market. We also carry out fetal blood transfusions, amniocentesis, placental biopsies and umbilical cord blood samples in cases of fetal anemia. My colleagues and I scan around 30 patients every day.

And what is the focus of your treatment?
My focus is on fetal cardiology and the early diagnosis of malformations. In terms of fetal treatment, we deal with a range of issues, including treatment of cardiac arrhythmia.

Why did you choose the Aplio i800 and what is your opinion of the image quality?
The main reason for our choice was the excellent B-mode image quality. The image quality is significantly superior to the results produced by other equipment, especially when scanning conditions are less than ideal. We still get very good images, even in case of increased abdominal wall thickness. This allows us to provide excellent image quality for a relatively broad patient population. We achieve very good results for the weight category of around 100 kg, not just for slim women – a completely new experience for me. We routinely perform an abdominal scan for clinical diagnostics, and in rare cases we have to carry out time-consuming vaginal scans.

As a specialist in fetal cardiology, what is your opinion of the color quality of the Aplio i800?
The color-coded display of the blood flow is very good, and it lets us detect the blood flow and its correct flow direction inside the vessels. The Advanced Dynamic Flow Doppler method is very sensitive and delivers a precise and detailed image of even the smallest vessels and complex flow patterns. Another remarkable feature is that we can make cardiac diagnosis much earlier, thanks to the improved technology. A four-chamber view is possible as early as the 12th/13th week of pregnancy, even though the heart is only the size of a corn kernel. We can see a precise, separate display of the vessels and the chambers of the heart on the left and right side, both with B-Mode and Color Doppler. The high image quality means we can make our diagnoses very efficiently and quickly.

What are the consequences of these early opportunities for diagnosis in terms of treatment?
It goes without saying that this offers significant advantages for planning the ongoing pregnancy. In case of heart defects, we can arrange appointments for check-ups at much shorter intervals. Or we can take therapeutic action and administer fetal drug therapy, if necessary.

How easy do you find it to use the Aplio i800?
In the past, Canon Medical wasn't seen as particularly user-friendly, but that has changed noticeably. The workflow is now very good and the ultrasound equipment is wonderfully quiet in use. I had no problems with the switch.

Would you recommend the Aplio i800?
Yes, I would definitely recommend the Aplio™ i800 to colleagues with a diagnostic focus. The B-mode image in particular, but also the color presentation inspires. //

Prof. Dr. Martin Krapp
Specialist in prenatal medicine, focusing on fetal cardiology.

About Dr. Martin Krapp:
- *Amedes experts is a specialist medical center, based in Hamburg, Germany, for fertility, prenatal medicine, endocrinology and osteology.*
- *As well as first-trimester screening, the center also offers malformation diagnostics, fetal echocardiography and Doppler ultrasound scanning, as well as placental sampling and amniocentesis.*
- *Prof. Dr Martin Krapp specializes in gynecology and obstetrics, focusing on special obstetrics and perinatal medicine.*
- *Prof. Krapp is a DEGUM-III ultrasound and DEGUM-II seminar leader.*
- *Prof Krapp teaches at the Lübeck campus of the University Medical Center Schleswig-Holstein.*

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All articles should be double-spaced.

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Full length articles should generally include the following:
- Author's full name and highest academic degree, employer medical institution
- Author's biography (150 words)
- Author's passport-size photograph (suitable for publication); (image of 300 dpi)
- 200-word abstract
- Text including headline, sub-title, introduction and sections like: materials & methods (which should include a full description of equipment used), results, discussion and references
- Text approx 4 to 5 pages or 12.000 to 14.000 characters (not including figures, tables and photographs)
- Correspondence address
- Literature (no more than 10 references)
- Separate, continuous numbered image- and table captions

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Cite all figures and tables in text, preferably in consecutive order. Please include a caption for each figure. All captions for each figure, should be separate from the text, at the end of the manuscript on a separate page. Captions should avoid duplication of text material. Credit lines for artwork can appear at the end of the corresponding caption by stating: (Provided by first initial, last name). Black out (or give clear instructions which parts should be blackened out) of the images to not violate any data protection regulations (e.g. patient data)

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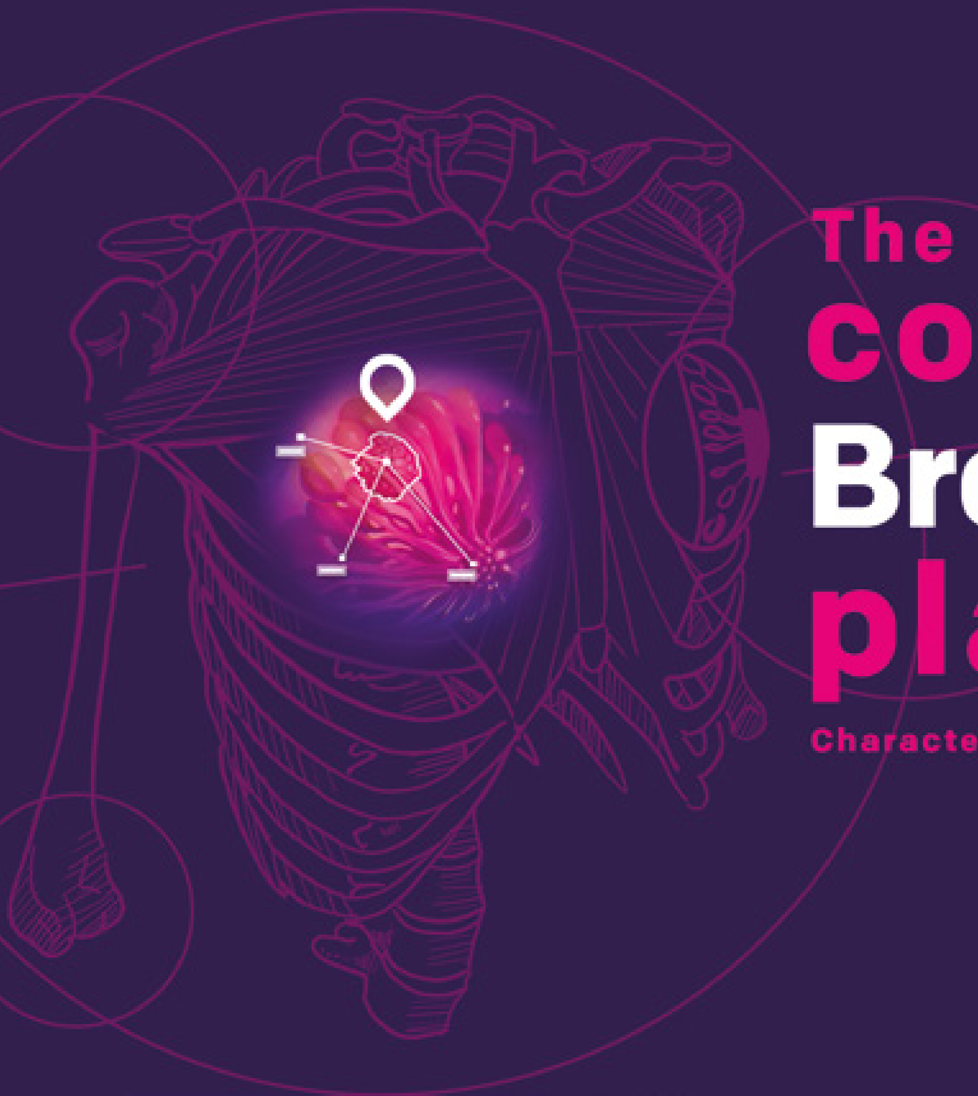

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