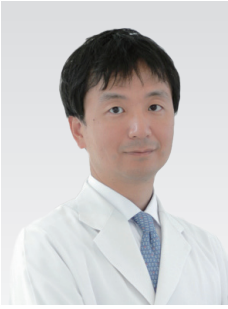
Ultrasound / Interview report

Objective echocardiography with superior reproducibility based on Artificial Intelligence technology



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Introduction

Aplio i-series / Prism Edition provides powerful imaging with a whole spectrum of flexible, AI-assisted productivity functions powered by Altivity, Canon's new AI brand. The smart, AI-driven algorithms allow clinicians to create simple and streamlined workflows to deliver fast, accurate results, and a more personalized treatment of the patients.

Tokushima University Hospital

"Altivity" is Canon Medical Systems Corporation's brand name for a range of AI solutions, in which AI technology is employed to achieve the most advanced precision medicine. The brand includes a variety of products and techniques that maximize clinical value in medical practice, system operation, and hospital management with the aim of promoting better healthcare.

Tokushima University Hospital, which has installed two premium Aplio i900 / Prism Edition ultrasound systems in their Ultrasound Examination Center, is a leader in the use of AI technologies in echocardiography. We interviewed Dr. Kenya Kusunose, an Associate Professor in the Department of Cardiovascular Medicine of Tokushima University Hospital, to discuss the fundamental concepts and future prospects of AI in the field of ultrasonography and also to share his personal expectations for Altivity.

Performing examinations, providing training, and conducting research in the Ultrasound Examination Center

All medical professionals involved in ultrasound examinations, including diagnostic ultrasound technicians and other specialized staff, are consolidated in the Ultrasound Examination Center. They provide ultrasound-related services to all the clinical departments in the Hospital, with the exception of obstetrics and pediatrics. In 2021, the center performed a total of 17,430 examinations, including 6,300 transthoracic echocardiography studies and 154 stress echocardiography studies. In addition to their two Aplio i900 / Prism Edition systems, the center also uses ultrasound systems from other manufacturers. Eight ultrasound technicians and resident physicians use all of these systems to perform ultrasound examinations.

"The center is set up to ensure smooth and efficient operation, with cardiologists on duty at all times to handle the diverse demands of cardiovascular examinations," explained Dr. Kusunose. "We also focus on providing training for resident physicians and new operators under the close supervision of senior physicians."

* Deep learning technology is used in the design stage of the system. The system itself does not have self-learning capabilities.
* The availability of AI-enabled functions depends on the regulatory requirements of each country.



Dr. Kusunose performing strain analysis using Aplio i900 / Prism Edition

Echocardiography for detailed analysis and high accuracy

In cardiac ultrasound (echocardiography), M-mode, B-mode, Doppler, and other imaging techniques are used to examine the heart and assess both its structure (morphological characteristics, cardiac volumes, etc.) and function (wall motion, valve function, hemodynamics, etc.). In recent years, there have been many technological advances in diagnostic ultrasound systems, and many new scanning techniques and applications have been developed, such as 3D cardiac echo and strain analysis. The number of measurements that need to be performed in routine clinical practice is, therefore, rapidly increasing. Dr. Kusunose notes that a standard echocardiography report today includes twice as many items as a report from 15 years ago. The increase in the number of examination items is a testament to the excellent reliability of echocardiography, but in order to perform such specialized and complex examinations with high accuracy and efficiency, high-level automated diagnostic support technology is required. It is important to develop new functions to improve examination workflow, such as image quality optimization and examination support functions based on the latest advances in AI technologies, such as deep learning.

Aplio i900 / Prism Edition with advanced functions developed using AI

The most advanced applications developed using AI are installed in the Aplio i900 / Prism Edition systems used at the Ultrasound Examination Center. In addition to CPU and GPU upgrades to achieve higher resolution, the systems feature new applications in which AI technologies, such as deep learning are employed during the development stage. These include Measurement Assistant, an automatic measurement function, Auto Plane Detection, an automatic cardiac plane detection function, as well as Automatic initial contour trace, an automatic contour tracing function.

Measurement Assistant is extremely useful when performing waveform trace measurement, which can be a very time-consuming process when the conventional methods are employed. Automatic measurement based on AI is most frequently used to evaluate the LVOT (left ventricular outflow tract) and AV (aortic valve). Through the algorithm trained with measurement points data acquired by experts, the system achieves higher accuracy than conventional automatic measurement. Dr. Kusunose has observed that the Aplio i900 / Prism Edition provides clear base images and extremely accurate automatic measurements, allowing the time required for examination to be substantially reduced.

In addition, with the Auto Plane Detection, when strain analysis is performed in the software for myocardial wall motion analysis, 2D Wall Motion Tracking (2D WMT), the left ventricle (LV), left atrium (LA), right ventricle (RV), and right atrium (RA) can be detected by a single button click. With the Automatic initial contour trace, the contours are automatically traced together with the automatically detected planes, reducing the time required for analysis.

"Reliable 2D WMT ensures the stable strain measurement thanks to the system's high detection accuracy," said Dr. Kusunose. "To maximize efficiency during analysis, the number of clicks to adjust the measurement points made by the operator should be minimized, but this means that the system must provide a sufficiently high level of accuracy."

Strain analysis is attracting a great deal of interest today because it can be used to monitor changes in cardiac function in patients with cancer who are receiving treatment, such as chemotherapy. Although strain analysis results have been added as new measurement items in routine echocardiography reports, the Hospital has found that examinations can still be completed in the same amount of time as before thanks to these automatic measurement functions.

"AI can be expected to improve image quality and measurement reproducibility, thus improving workflow by reducing the time required for examination and creating new clinical value through automated diagnostics," said Dr. Kusunose.

Utilizing AI in echocardiography at Tokushima University Hospital

Dr. Kusunose is a pioneer in the development of automatic diagnosis support technologies for ultrasound in the field of cardiology. Since 2018, he has conducted extensive research on the applications of AI in echocardiography based on the observation that ultrasound imaging has previously been strongly dependent upon the skill and experience of the operator, meaning that diagnosis is based on subjective visual evaluation.

Although technological advances in diagnostic ultrasound systems have led to remarkable improvements in image quality, allowing examination and analysis to be performed based on more accurate images, Dr. Kusunose has always felt the need for new analysis technologies that are able to provide higher levels of objectivity and reproducibility. The application of AI technologies such as deep learning to medical image analysis continues to advance in the field of radiology.

"I thought that using AI in ultrasound imaging would improve image quality and enable objective and highly reproducible diagnosis employing new indices based on quantitative analysis and other approaches," he said.

Dr. Kusunose identifies four phases in the process of implementing AI in automatic diagnosis. These are: 1) image quality evaluation, 2) plane/segment classification, 3) measurement, and 4) abnormality detection.

Automatic analysis function developed using AI installed in Aplio i-series / Prism Edition

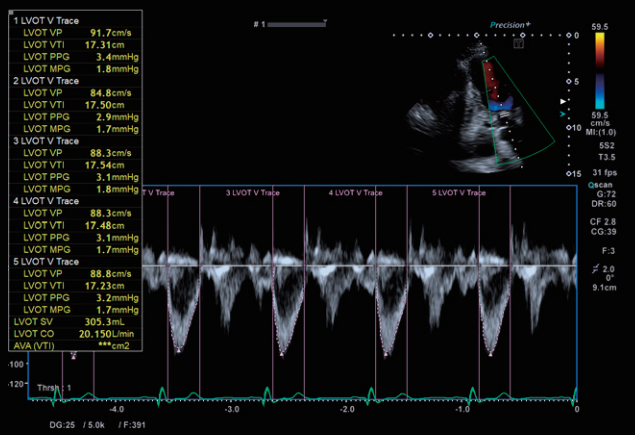


Figure 1 Automatic LVOT measurement using Measurement Assistant

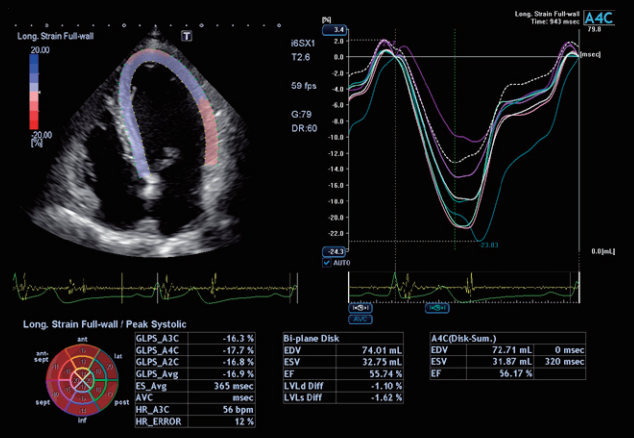


Figure 2 Auto Plane Detection and Automatic initial contour trace in 2D Wall Motion Tracking

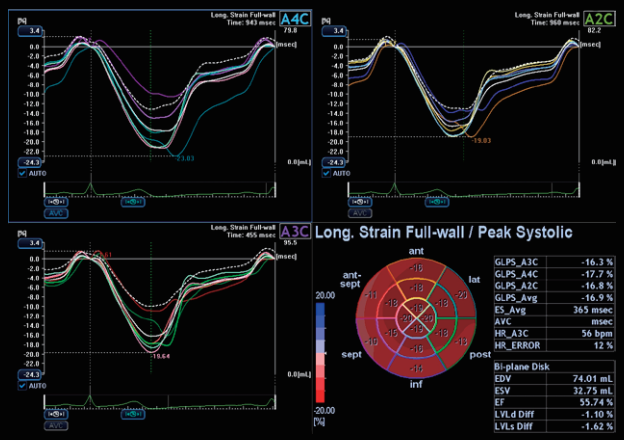


Figure 3 Details of analysis for each plane displayed together with the Polar Map and analysis results

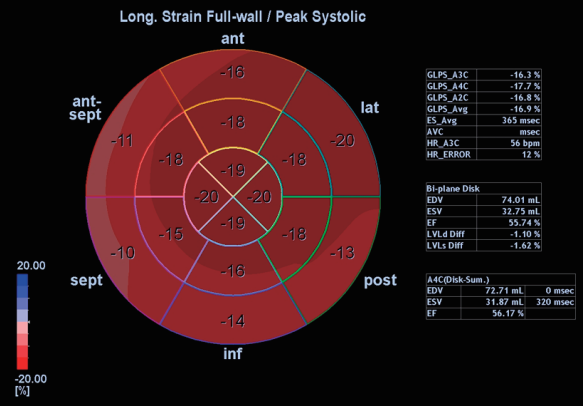


Figure 4 Polar Map display and calculation results showing the LV strain distribution and detailed calculation results

powered by Altivity



Tokushima University Hospital has developed a plane classification model (plane/segment classification)[1], a left ventricular ejection fraction (LVEF) estimation model (measurement)[2], and a regional wall motion abnormality detection model (abnormality detection)[3] based on a convolutional neural network (CNN). Dr. Kusunose also notes that in order to apply AI to echocardiography, accurate classification of the planes and segments is essential for reliably recognizing complex cardiovascular structures. He has, therefore, used such images to develop models for measuring LVEF and detecting wall motion abnormalities. These models have shown excellent agreement with the results of evaluation performed by experts, clearly demonstrating the great potential of AI in supporting cardiac examinations. In addition, Dr. Kusunose is currently working to develop a model that allows the AI system to learn the 'visual EF,' as determined by experts and reflect the results in automatic analysis.

Latest developments in AI for echocardiography led by Dr. Kusunose and his team

"With regard to the future directions of AI development in the field of cardiac ultrasound, our immediate challenge is to further improve reproducibility," Dr. Kusunose remarked. "It must be possible to obtain highly accurate data in the same easy way, no matter who is performing the examination. Although only a few guidelines, such as those in the field of cardio-oncology, include items related to 'reproducibility' in ultrasound examinations, high reproducibility is an essential factor in diagnosis and treatment planning based on ultrasound examination results. If AI can be used to obtain stable and reproducible images and measurement results, we can expect ultrasound systems to make even greater contributions to therapeutic decision making."

On the other hand, the main focus of Dr. Kusunose's AI research is the differential diagnosis of pathological conditions in the future.

"I believe that automatic measurement and diagnosis will be realized by manufacturers of medical equipment, so we, on the clinical side, will focus on the development of AI that can detect new pathologies and diseases," he added.

As the key institution in the imaging-related database project of the Japan Agency for Medical Research and Development (AMED), Tokushima University Hospital is taking the lead in the creation of a cardiovascular ultrasound imaging database in Japan. Future research and development to maximize reproducibility in echocardiography and further improve workflow by the introduction of automation is eagerly anticipated.

(Interview conducted on June 27, 2022.)

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Altivity

Altivity is a new approach to AI innovation. It is a multimodality, overarching brand for healthcare, which pulls together all the AI technology that Canon provides under one name.

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