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The intelligent way to evaluate fetal CNS: ViewAssist™ and BiometryAssist™

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Introduction

Ultrasound (US) is an indispensable tool in the field of obstetric care. However, fetal US scanning is a time-consuming and labor-intensive process of which performance outcome is greatly affected by the operator's skill level and knowledge. As overcoming such workload or operator-dependency associated with fetal scanning is a paramount issue, the role of artificial intelligence (AI) technology in fetal ultrasound has been actively explored.

Recently, machine-learning techniques have brought significant advancements in US image classification, localization and automated measurement in the field of obstetric US.[1-6] Application of AI-assisted systems is very promising in reducing redundant manual steps and improving accuracy of structure localization, caliper placement and measurement.[7-9]

ViewAssist™ and BiometryAssist™ are built-in, commercially available automated ultrasound imaging software installed on the high-resolution ultrasound system HERA W10, W9, and I10 (SAMSUNG MEDISON Co., Ltd, Seoul, Korea). Recently, ViewAssist™ and BiometryAssist™ have been upgraded to include standard measurements on axial fetal head planes based on machine learning.

As shown in Figure 1, these newly upgraded features can automatically recognize the standard axial planes of the fetal brain – transventricular (TV), transthalamic (TT), and transcerebellar (TC), and provide annotations and measurements of relevant structures according to the International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) recommendations (Table 1).[10-11]

Table 1. Annotations and measurements of relevant structures according to view planes.

View Plane	Annotation	Measurement
Transventricular (TV)	Choroid plexus (CP)	Lateral ventricle width (LVw)*
Transthalamic (TT)	Thalamus	Biparietal diameter (BPD) Head circumference (HC) Occipitofrontal diameter (OFD)
Transcerebellar (TC)	Cerebellum (CEREB) Cisterna magna (CM)	Transverse diameter of cerebellum (CEREB) Depth of cisterna magna (CM) Nuchal fold thickness (NF)

*Please note that lateral ventricle width(LVw) is currently expressed as Vp on the system.

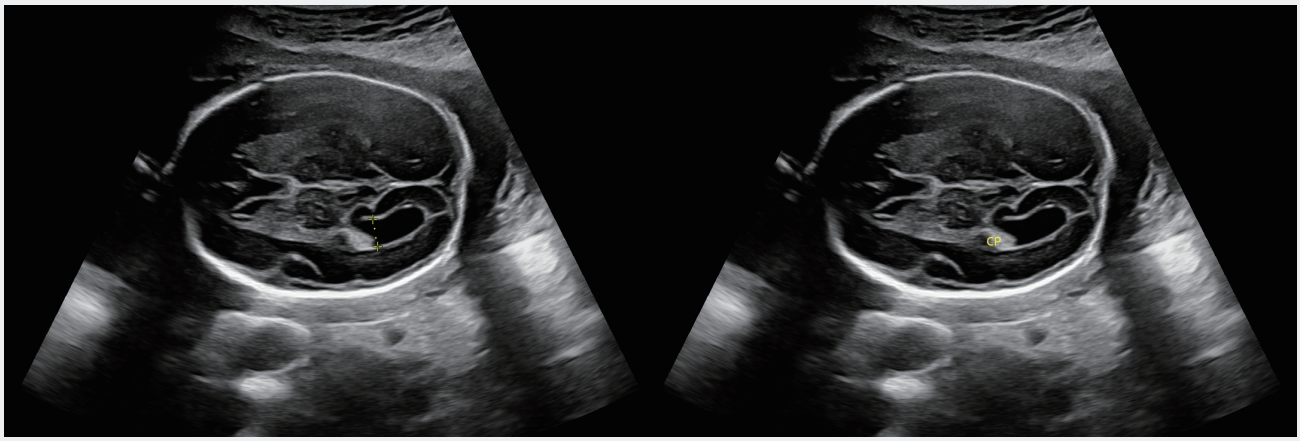

Figure 1a. Transventricular plane (TV): The atrium of the lateral ventricle is measured automatically by selecting the **[Auto Measure]** button (Left). The choroid plexus (CP) is automatically annotated by selecting **[Auto Annotation]** button (Right).

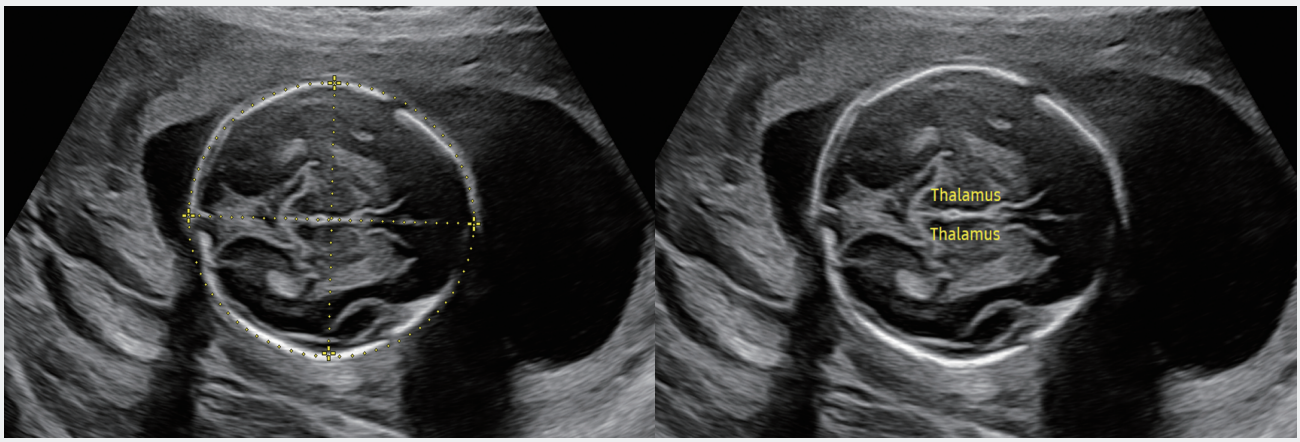

Figure 1b. Transthalamic plane (TT): Biparietal diameter and head circumference are measured automatically by selecting the **[Auto Measure]**. Additionally, the occipitalfrontal diameter (OFD) can be measured by selecting **[OFD]** on the touch screen (Left). The thalamus is automatically annotated by selecting **[Auto Annotation]** on the touch screen(Right).

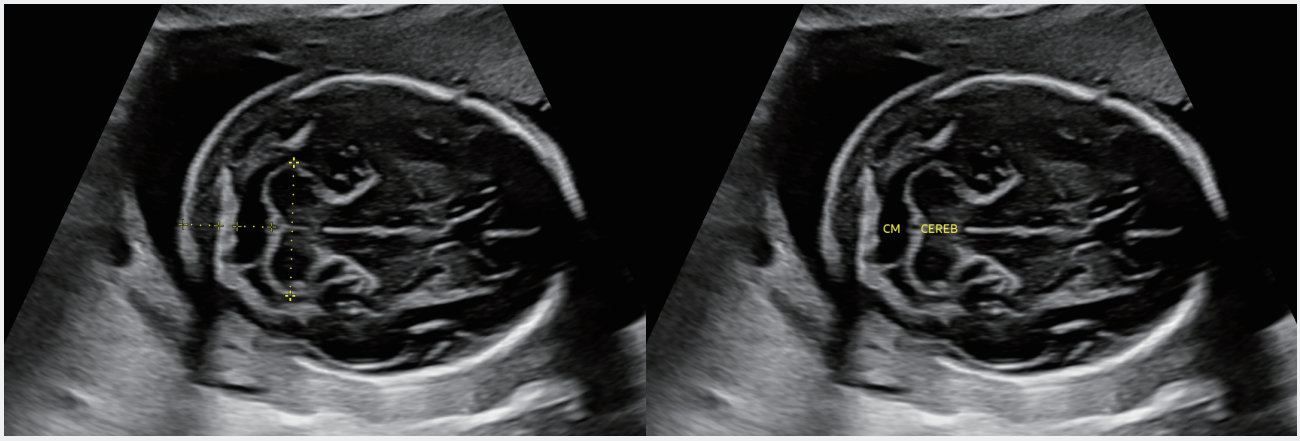

Figure 1c. Transcerebellar plane (TC): The transverse diameter of cerebellum is measured automatically by selecting **[Auto Measure]**. Additionally, the cisterna magna (CM) and nuchal fold (NF) can be measured by selecting **[CM]** and **[NF]** on the touch screen (Left). The cerebellum (CEREB) and cisterna magna are automatically annotated by selecting **[Auto Annotation]** on the touch screen (Right).

Methods and results

The diagnostic performance of these algorithm-based tools developed using big data was validated using 890 US fetal head images obtained in the axial plane. The rate of standard axial plane recognition was 94.5% and accuracy in annotating relevant structures was 90.0%. The success rates of accurate and automated caliper placement for measurement relevant to TV, TT, and TC were 100, 98.0, and 98.3%, respectively. The performance of ViewAssist™ and BiometryAssist™ was robust and reliable for clinical application.

Furthermore, ViewAssist™ and BiometryAssist™ improved workflow efficiency by reducing the number of keystrokes required compared to manual measurement in routine ultrasound examinations. Figure 2 summarizes steps involved in manual fetal central nervous system (CNS) axial plane measurement versus using ViewAssist™ and BiometryAssist™. With a single touch of the measure button on the fetal head image, the plane is automatically recognized and classified, and measurements are displayed in less than a second. Given that manual caliper placement takes approximately 5, 15, and 10 seconds for biometric measurements specific to TV, TT, and TC planes, respectively, application of the automated system was efficient in reducing scan time.

However, there is still room for further advancement. Firstly, validation showed that ViewAssist™ and BiometryAssist™ performed particularly well in the second trimester. This is probably because the training data mainly consisted of images from the second trimester of pregnancy. Therefore, further training of the algorithm using images from all trimesters is expected to enhance performance. Secondly, incorporating the step of image accuracy check into the present algorithm will not only increase the work efficiency itself, but also add precision to clinical practice.

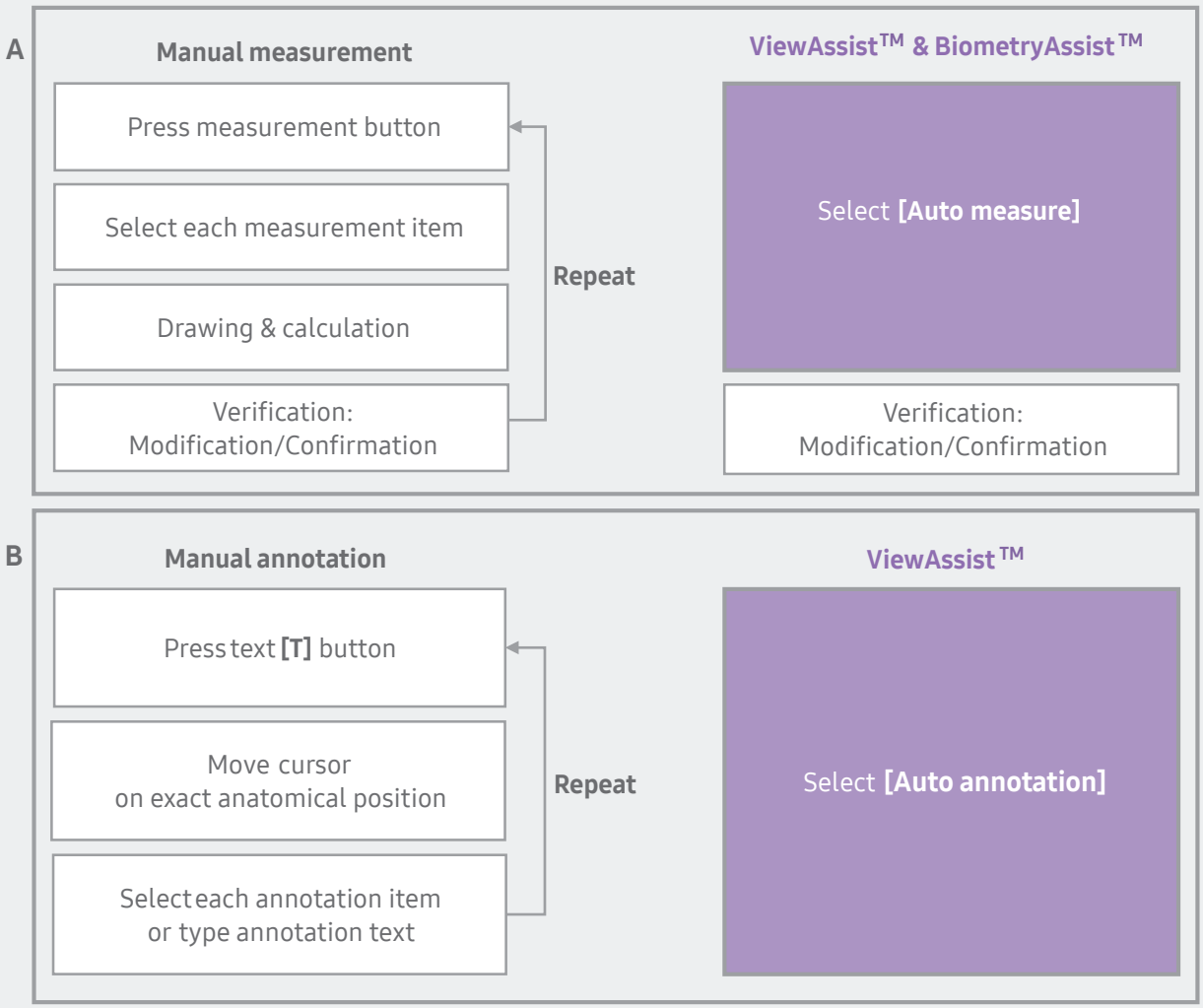

Figure 2. The comparison of workflow between manual procedure and machine learning-based ViewAssist™ & BiometryAssist™: (A) Measurement procedure, (B) Annotation procedure

* Note that the manual procedure requires repeated keystrokes for each measurement and annotation, while ViewAssist™ & BiometryAssist™ can provide results in a single step.

Conclusion

With Samsung's ViewAssist™ and BiometryAssist™, saving time and reducing physical workload can potentially improve work efficiency and contribute in overcoming operator dependency associated with caliper placement. Application of the recently upgraded ViewAssist™ and BiometryAssist™ automated ultrasound imaging software is an intelligent way to evaluate the fetal CNS.

Supported system: HERA W10 (V1.02)

ViewAssist & BiometryAssist are available in the following systems - HERA W10/W9/I10

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[Abbreviations]

CNS: Central Nervous System

AI: Artificial Intelligence

TV: Transventricular plane

TT: Transthalamic plane

TC: Transcerebellar plane

CP: Choroid plexus

CEREB: Transverse cerebellar diameter

CM: Depth of the cisterna magna

BPD: Biparietal diameter

HC: Head circumference

OFD: Occipitofrontal diameter

NF: Nuchal fold thickness

Vp: Posterior horn of the lateral ventricle

LVw: Lateral ventricle width

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