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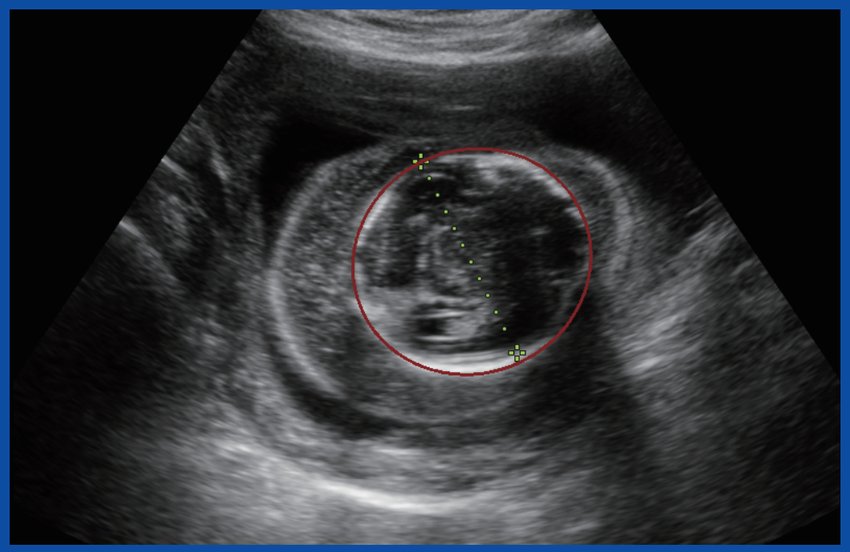
Feasibility of improved algorithm-based BiometryAssist™ in fetal biometric measurement



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WP-BiometryAssist-IMC-190705-EN

Introduction

Rapid advances in the field of computer vision have been seen across many domains, fostered by the application of image processing algorithm to “Big-data”. Especially in medical imaging field, various attempts were made to improve the quality of images and the performance of previous algorithms by using data analysis models taking into account unique characteristics of ultrasound images [1-5].

In fetal biometry estimation, the need for performance improvement was required in order to apply the previous semi-automatic fetal biometry estimation to a variety of real clinical environments [6]. In order to finesse the performance of BiometryAssist™ in fetal biometry measurement, large numbers of actual clinical cases were incorporated into the algorithm. In particular, the performance was improved by extracting the major factors needed for BPD, HC, AC, and FL* measurements using the anatomical information of various actual clinical cases.

The aim of this study was to assess the diagnostic performance of BiometryAssist™ by validating various clinical cases. A semi-automated measurement for BPD, HC, AC, and FL of fetal biometry using BiometryAssist™ is expected to improve workflow efficiency for routine ultrasound examinations and minimize operator dependent error.

*BPD : Biparietal diameter, HC : head circumference, AC : abdominal circumference, FL : femur length

Material and Methods

Task 1, Image Acquisition
Actual diagnostic images were selected randomly to collect 1322 clinical data.

Task 2, Image Classification
Collected data were classified into four groups,
BPD, HC, AC, and FL as the subject of experiments.

Task 3, Semi-auto BiometryAssist™
The fetal growth indicator was semi-automatically measured with BiometryAssist™ in each image.
No further edit work was carried out.

Task 4, Clinical Validation
The results were evaluated by an expert*.

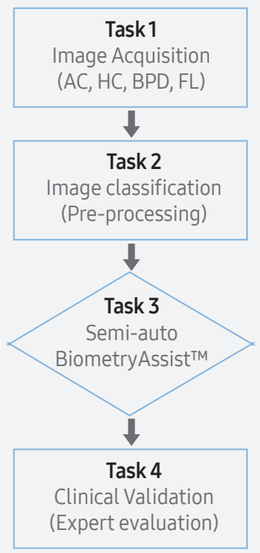

Figure 1. Schematic outline of the study
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BiometryAssist™ is a built-in, commercially available software installed on the high-resolution ultrasound system HERA W10 (SAMSUNG MEDISON, CO., LTD. Korea). 1322 biometry images from 520 pregnant women who had undergone fetal ultrasound between 20+0 and 36+0 weeks of gestation using WS80A (SAMSUNG MEDISON, CO., LTD. Korea) from October 2018 through January 2019 were obtained from the image data bank of Department of Obstetrics and Gynecology, Yonsei University College of Medicine, Seoul, Korea. Images were classified into four groups according to fetal parts such as BPD, HC, AC and FL. No edit work on images was carried out. Using improved algorithm-based BiometryAssist™, calipers were semi-automatically placed for each fetal biometry parameters. The images were validated by expert and images were interpreted as ‘success’ if caliper was properly placed, and otherwise as ‘fail’ (Figure 1).

Results and Discussion

As a result, the success rate of improved algorithm-based BiometryAssist™ was over 97% in all of the fetal growth indicators (Table 1). When non-readable images due to extensive shadowing was excluded from analysis, the success rate was 98-99%. From these results, we demonstrated that success rate in automatic caliper placement using improved algorithm-based BiometryAssist™ was significantly higher when compared to the previous algorithm [6].

Table 1. Success rate for BPD, HC, AC, and FL caliper placement using improved algorithm-based BiometryAssist™

Parameter	Including non-readable images	Excluding non-readable images* (such as image shadowing)
BPD	97.9% (231/236)	98.3% (231/235)
HC	97.7% (383/392)	99.0% (383/387)
AC	97.2% (447/460)	99.8% (453/454)
FL	98.4% (240/244)	98.4% (240/244)

Acceptance rate: percentage of images with proper caliper placemen out of total image input
* Non-readable images: poor quality image due to massive shadowing

It was a hurdle for conventional methods to delineate HC and AC in the presence of shadowing, abutting placenta or other fetal part, and absence of amniotic pocket [7,8,9] which substantially deteriorated the success rate, however, the improved algorithm-based BiometryAssist™ was able to overcome such artifact (Figure 2,3,4).

Our experience suggests that the improved algorithm-based BiometryAssist™ can be utilized as a useful diagnostic tool for monitoring fetal growth, enabling users to measure the growth of the fetus more quickly and with greater accuracy.

In addition, improved performance reduced workflow compared to the manual method (Figure 5), In detail, BiometryAssist™ semi-automated method is implemented as a single step manner, whereas there are three steps (measurement item select, drawing and calculation, verification) in the manual method. Therefore, improved algorithm-based BiometryAssist™ is likely to contribute to improving work efficiency and to reducing examiner’s fatigue considerably.

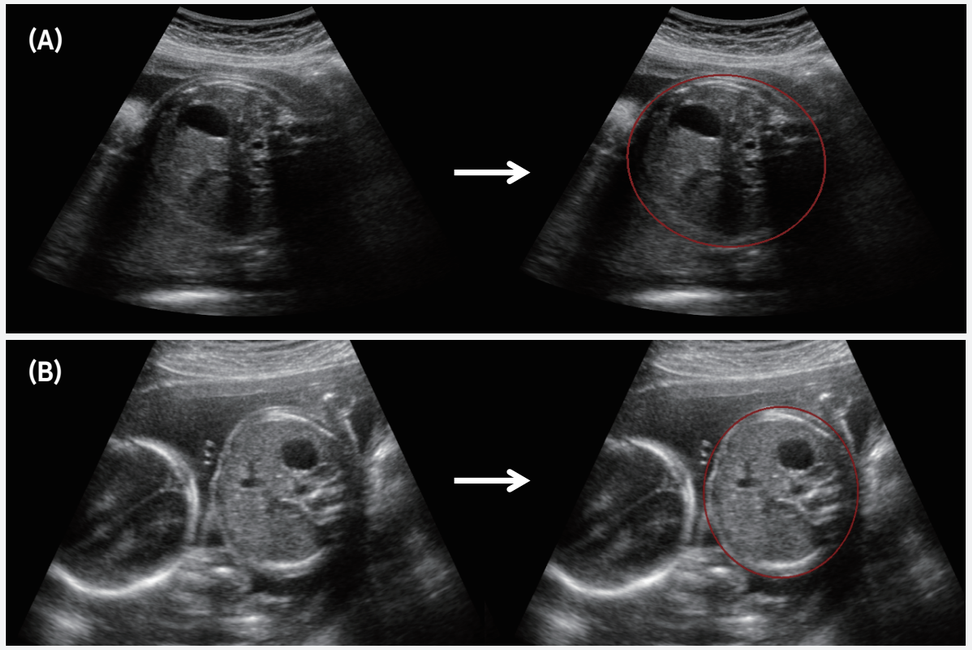

Figure 2. Improved algorithm enables to place caliper around AC even when fetal abdomen was abutting placenta with moderate amount of shadowing (A), or was next to other round structure such as fetal head.

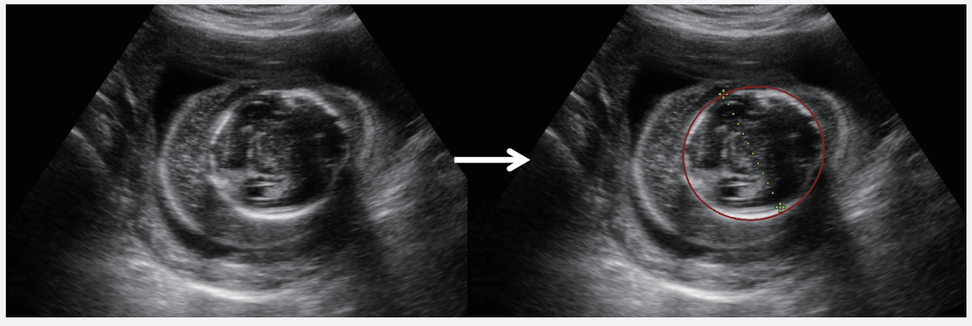

Figure 3. Successful delineation of BPD and HC in cystic hygroma fetus at early second trimester. The system was able to discriminate true cranium outline from the echogenic skin line around it.

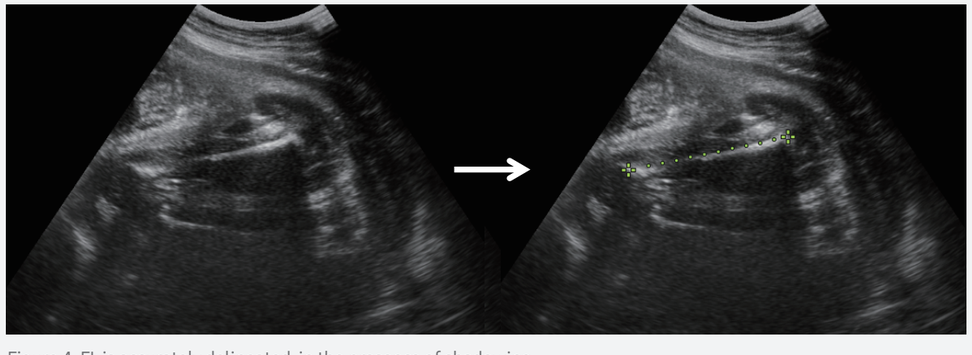

Figure 4. FL is accurately delineated in the presence of shadowing

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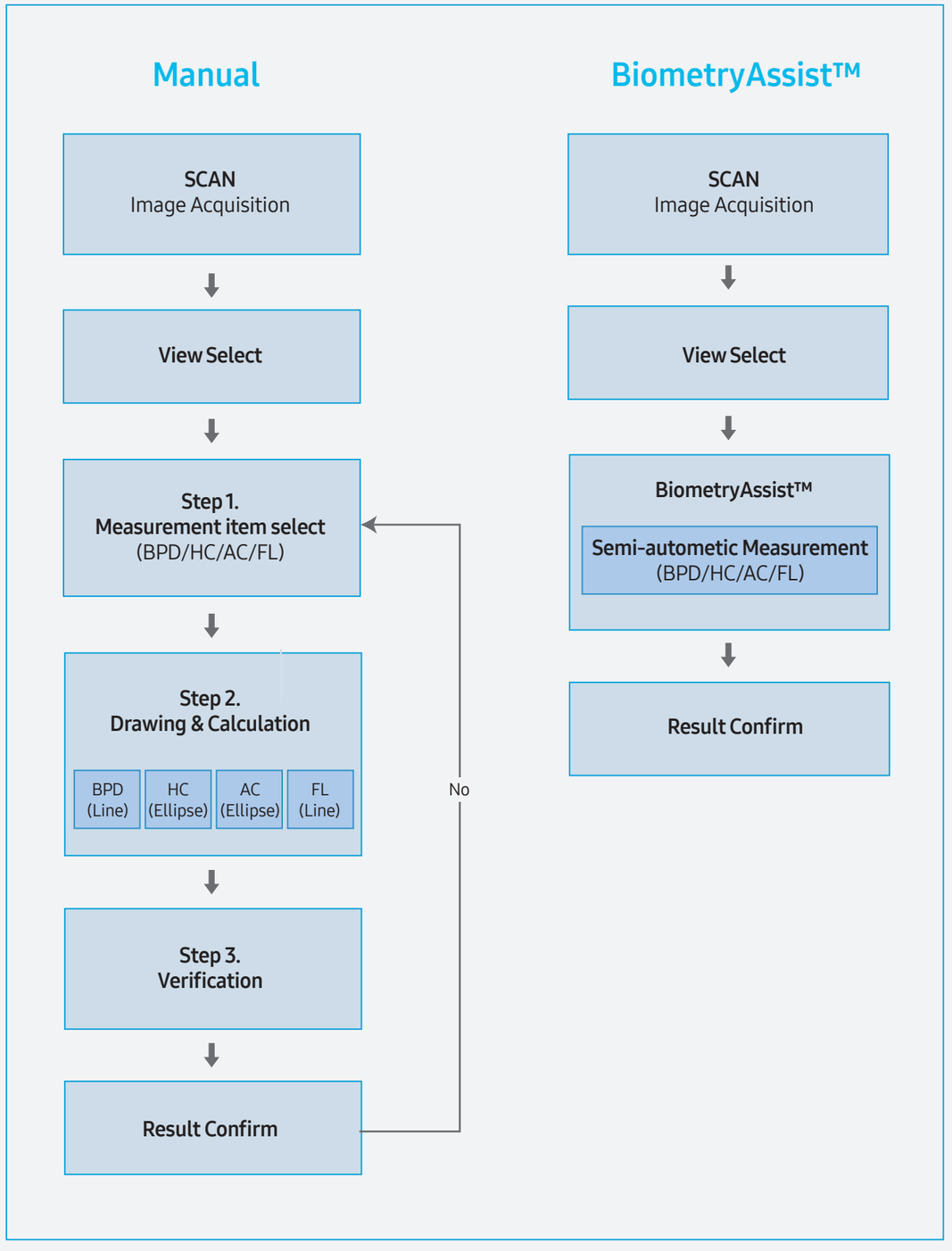

Figure 5. The comparison of workflow in manual and improved algorithm-based BiometryAssist™

Conclusion

Ultrasound is an invaluable tool in the field of obstetrics for fetal diagnosis. And estimation of fetal weight by combining head, abdomen and femur biometry is the basis of fetal assessment. However, fetal biometric measurement is time-consuming and inappropriate caliper placement leads to imprecise fetal weight estimation.

In this context, application of automated system can be the solution to improve clinicians' cumbersome workflow and to overcome operator-dependency [10]. BiometryAssist™, semi-automated fetal biometry measurement system that automatically locates the region of interest and places caliper for fetal biometry, demonstrated a success rate of 97-99% for each parameter. Such high efficacy enables its use in the current clinical practice with high precision. Furthermore, the system can be used for on-site educational purpose for trainees to improve measurement performance by providing feedback on proper caliper placement. As obtaining a proper plane is prerequisite to accurate measurement, the incorporation of an algorithm for recognition of standardized planes would be helpful for fetal estimation.

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BiometryAssist™ is available in the following systems

- HERA W10 v1.00.06 or later
- HS60 v2.02.00 or later
- HS50 v2.02.00 or later

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