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W H I T E P A P E R

First experiences with High Definition Volume Imaging (HDVI™) in obstetric ultrasound

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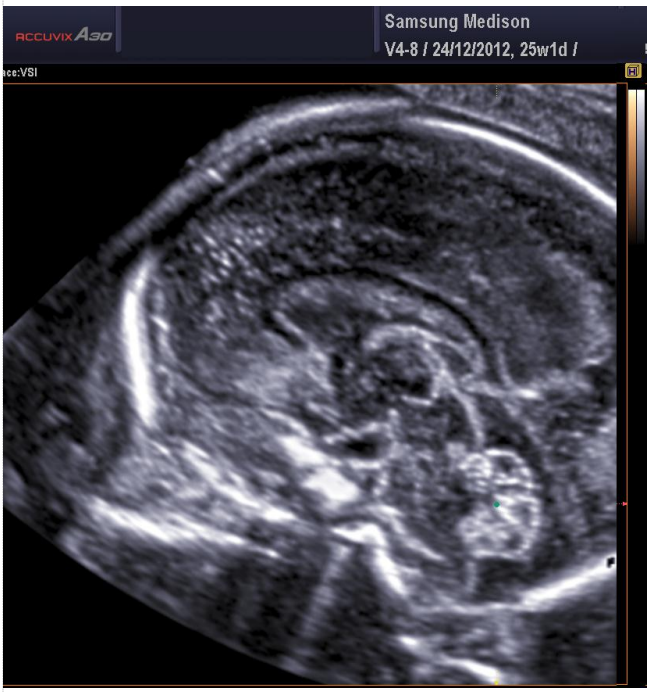
INTRODUCTION

In recent years, three-dimensional (3D) ultrasound has been accepted as a valuable tool in prenatal diagnosis of fetal anomalies [1-3]. 3D ultrasound allows reconstruction of planes which are difficult or impossible to visualize directly by 2D technique [1-6]. Recent developments allow faster volume acquisition reducing movement artifacts which can disrupt the 3D volume dataset. The application of multiple display modes makes understanding and analysis of fetal anatomy easier for clinicians [3].

High Definition Volume Imaging (HDVI™) is a next generation technology for the improvement of 3D image quality to the level of 2D image quality.

3D ultrasound has been found to be particularly useful for evaluation of the fetal face, CNS and spine in the 2nd and 3rd trimesters [1-3]. 3D examination of the fetal face has received the greatest amount of attention from parents, media and also clinicians [2]. This technique was found to provide beneficial clinical information mainly in the assessment of the integrity of the fetal palate [1, 2, 7].
According to the ISUOG guideline for fetal neurosonogram the fetal brain should be evaluated in all three orthogonal planes [8]. While it is usually easy to visualize the traditional transverse sections of the fetal brain with conventional 2D ultrasound, the so-called median plane is often very difficult to obtain. This plane is very important as it provides unique information about mid-sagittal intracranial structures such as the corpus callosum and the cerebellar vermis [5]. 3D ultrasound imaging improves the fetal brain examination as it allows simultaneous display of all three orthogonal planes [1-3, 8, 9].



For the fetal spine the addition of maximum mode rendering to the multi-planar view facilitates the diagnosis of hemivertebra with other vertebral anomalies and allows rapid and easy assessment of the fetal ribs [1-3].

As for the clinical usefulness of 3D ultrasound in the first trimester, the results remain mixed [3]. Some studies report about its benefits both in the assessment of fetal anatomy [10] and in the measurement of nuchal translucency [10, 11], while others have found the image quality to be unsatisfactory and thus inadequate for clinical usage [3].

Case 1: Mid-sagittal plane of a normal fetal brain at 21 weeks using 3D rendering in OVIX™

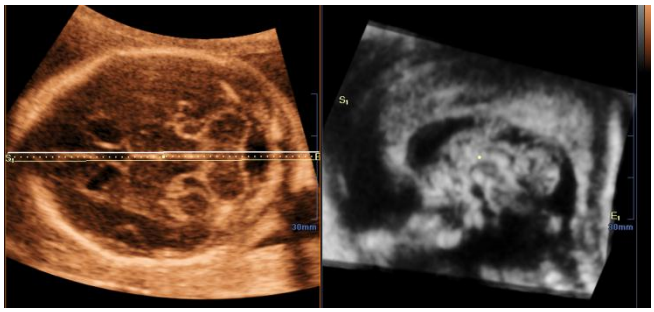


Fig. 1a) 3D rendering with OVIX™

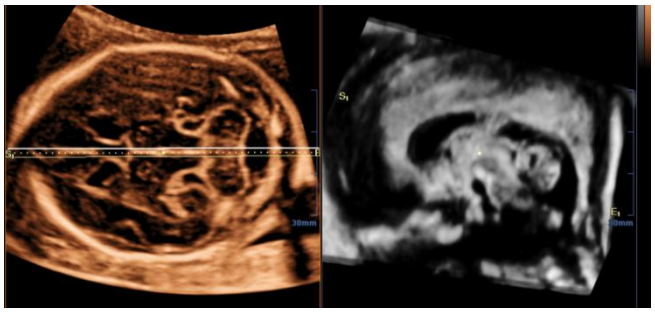


Fig. 1b) 3D rendering with OVIX™ and HDVI™

Case 1: Application of the Oblique View eXtended (OVIX™) thin slice 3D rendering allowed easy reconstruction of the mid-sagittal plane of the fetal brain from a volume which was acquired in the axial plane. Application of HDVI™ markedly improved the contrast and resolution resulting in easier and more detailed assessment.
In the HDVI™-applied transcerebellar plane, the borders of the lateral ventricle, thalami and Sylvian fissure with borders between fetal brain parenchyma and subarachnoidal space became clearer and could be assessed more easily. Similar improvement of image quality could be seen in the HDVI™ and OVIX™-applied image of the mid-sagittal plane, which is essential for the assessment of the presence and integrity of the corpus callosum and posterior fossa (insertion of tentorium as well as the morphology and position of the cerebellar vermis).

Case 2: Normal fetal spine examination at 21 weeks in multi-planar mode and 3D rendering maximum mode

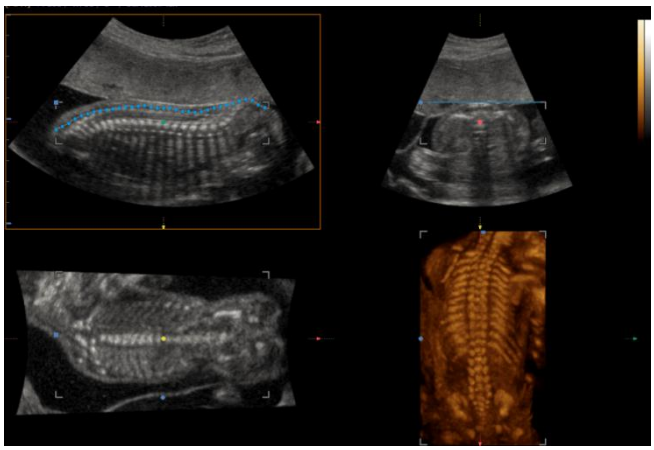


Fig. 2a) 3D rendering with Auto-Contour™

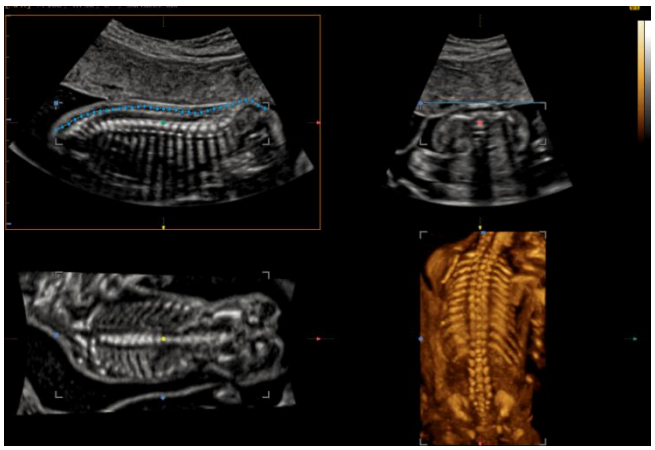


Fig. 2b) 3D rendering with Auto-Contour™ and HDVI™

Case 2: Fetal spine examination in the multi-planar mode with rendering of the fetal spine, ribs and pelvis. Application of the Auto-Contour™ allowed manual drawing of a line along the irregularly shaped spine, which helped to remove the soft tissues and reveal the skeleton. Both posterior processes and vertebral bodies could be seen in the rendered image. The morphology of the whole spine including individual vertebral bodies, number and appearance of ribs and pelvic bones could be assessed in one volume. Application of the HDVI™ post-processing increased contrast between bones and surrounding soft tissues both in the multi-planar mode and in the 3D rendered image.

Case 3: Examination of the fetal brain in a fetus with agenesis of the corpus callosum at 21 weeks

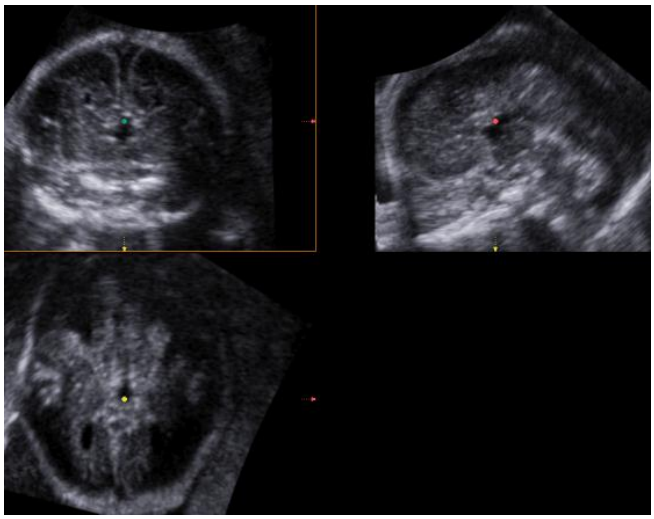


Fig. 3a) 3D multi-planar mode

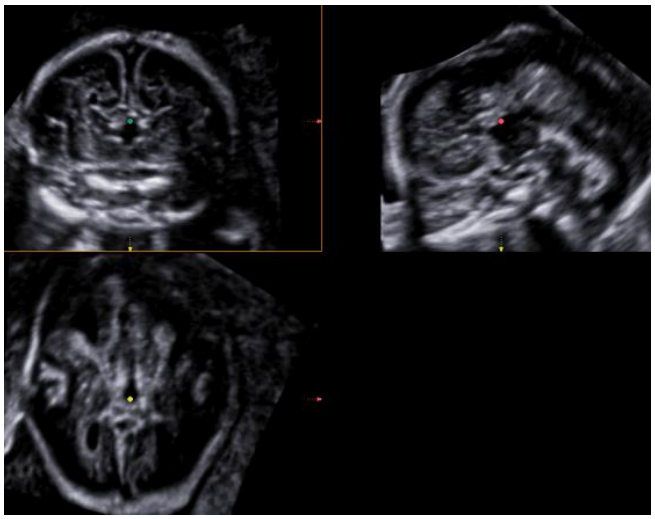


Fig. 3b) 3D multi-planar mode with HDVI™

Case 3: This 3D volume was acquired in the coronal plane. The application of HDVI™ markedly improved the image quality of the volume to the point where the signs of agenesis of the corpus callosum could be clearly seen. The complete absence of the corpus callosum in the mid-sagittal plane and the typical indirect signs of this anomaly: bullhorn shape of lateral ventricles, absence of cavum septi pellucidi, wide opening of the inter-hemispheric fissure in the coronal plane and the teardrop shape of the lateral ventricles were much more confidently diagnosed.

Case 4: Multi-planar 3D examination of joined twins at 11 weeks

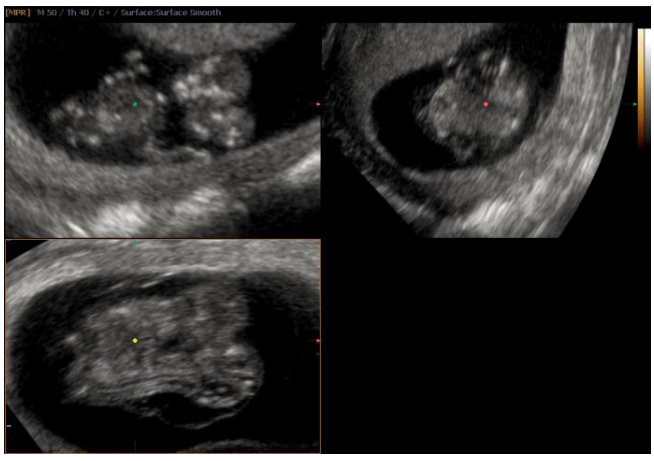


Fig. 4a) Multi-planar 3D

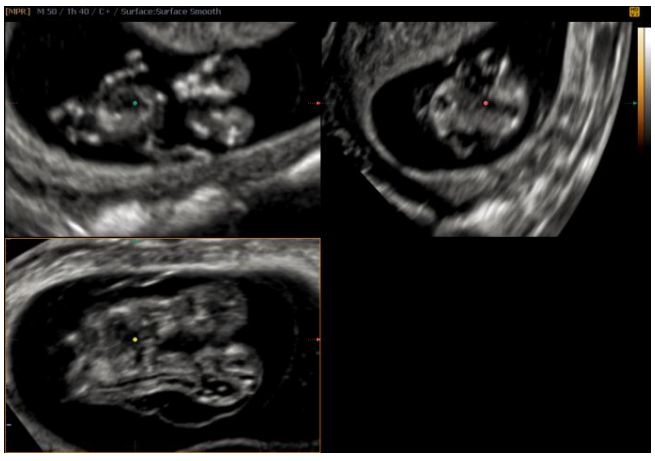


Fig. 4b) Multi-planar 3D with HDVI™

Case 4: During manipulation of the volume the point of interest (rotational dot) was placed into the junction of the fetuses thus displaying this area in all three perpendicular planes. The use of HDVI™ improved resolution of small details and provided better delineation of boarders. This allowed markedly easier identification of the site of the joined bodies (abdomen) and the involvement of organs (liver, stomach). Moreover, cord insertions on both fetal bodies and marked hydrops of both fetuses became more apparent on the image with HDVI™ especially in the reconstructed C-plane.

CONCLUSION

We have found several areas in fetal medicine in which application of this novel HDVI™ technology was useful. This unique technique improved the speed and accuracy of the examination and increased our diagnostic confidence. Major anatomical landmarks could be identified more clearly and manipulation of 3D volume datasets in multi-planar mode with 3D rendering of anatomical structures was facilitated. Furthermore, evaluation of subtle details of the fetal anatomy and more accurate measurements of the fetal structures were made possible with HDVI™.

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