

# Preliminary experience with Advanced Volume Contrast Imaging (VCI) and Omniview in obstetric and gynecologic ultrasound

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One of the greatest appeals of three-dimensional (3D) ultrasound is the possibility to analyze a stored volume using multiple section planes. The advantage is that, on one hand, these scanning planes can be directed with absolute precision, on the other hand, it is possible to reconstruct virtual planes that are physically impossible to visualize directly. The use of this approach in the investigation of the uterus and of fetal anatomy has been described in many publications.<sup>[1-9]</sup>

While performing a multiplanar analysis of a volume it is frequently convenient to employ Volume Contrast Imaging (VCI) (General Electric Healthcare) an application that consists in displaying a slice of variable thickness. One of the main purposes of this technique is to decrease ultrasound artifacts. By superimposing and adding different layers of tissue, speckles and noise pixels that are generated at random, are reduced or eliminated, while anatomical structures are enhanced. This results in an image that displays less noise pixels and has greater contrast resolution. It is yet to be demonstrated whether VCI increases the amount of information over standard multiplanar visualization. However, the images tend to be smoother and the contrast resolution is certainly enhanced.

However, thus far, multiplanar analysis could only be performed along the three orthogonal planes and using straight sections. We have had recently the opportunity to use the new release of the Voluson E-Series (GE Healthcare) with Advanced VCI and Omniview that allows to dissect a volume along plane even using curvilinear or irregular cuts.

We have found this tool to be particularly useful in a number of different situations, particularly when dealing with complex anatomy. In the following we will try to summarize our experience thus far in the attempt to delineate the modalities and fields of application of this new tool.

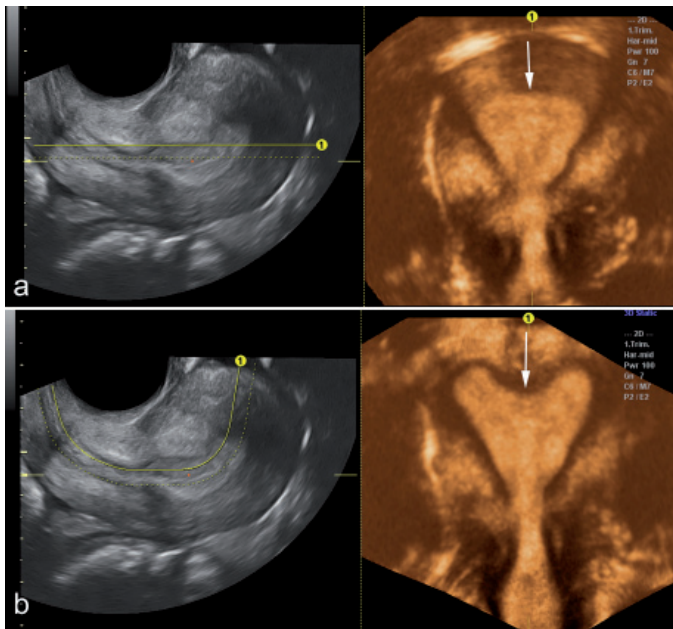


Figure 1: 3D sonography of the uterus. In a) the coronal plane has been obtained by a straight section, and demonstrates a rather normal looking endometrial cavity with a convex dome (arrow). In b) the coronal plane has been obtained with a curvilinear section that was drawn using the polyline tool of Omniview. An arcuate uterus (arrow) is clearly demonstrated. As in the following images, the reconstructed section have been obtained by using VCI. The thickness of the slice is indicated by the solid and dashed line in the reference images. The solid line indicates the point of view. Rendering of the slice was always obtained by mixing the X-ray and the surface smooth modalities or the X-ray and maximum mode modalities. Mixing of the modalities and transparency were individually adjusted to obtain the best results.



Figure 2: Virtual 'stretching' of this embryo to demonstrate in one single image the entire tree of the cerebral vesicles has been obtained by using the polyline tool of Omniview.

## CURVILINEAR AND COMPLEX PLANES OF SECTION

In general, the human body has round shapes and sometimes straight sections do not provide sufficient anatomic information. One remarkable example with this regard is the uterus. The use of 3D ultrasound has been advocated by many mostly to demonstrate a coronal plane, which can never be clearly imaged with 2D ultrasound and provides important anatomic information in particular with regard to the possible presence of Mullerian anomalies.<sup>[1, 3-5, 10, 11]</sup>

Figure 1 clearly indicates that given the shape of the uterus, that is folded upon itself variably in different patients, the morphology of the endometrial cavity is better demonstrated by a curvilinear section, traced with the polyline tool following rather than by a straight section.

Similarly, the complex tridimensional arrangement of the embryonic cerebral vesicles is very well demonstrated by virtually 'unfolding and stretching' the embryo as it is demonstrated in Figure 2.

The fetal palate represents another example. It is well established that 3D ultrasound is the best way to evaluate this structure, particularly because by using a specific approach, the secondary palate can be imaged, which is usually impossible by standard two-dimensional ultrasound.<sup>[7-9]</sup>

Visualizing the soft palate is however particularly challenging because it forms a rather sharp angle with the bony palate, and the structures together cannot be seen by using straight section. On the other hand, by using a curvilinear cut it is usually possible to demonstrate them both with a single virtual image<sup>[9]</sup> (Figure 3). Examples of anomalies are demonstrated in Figure 4.

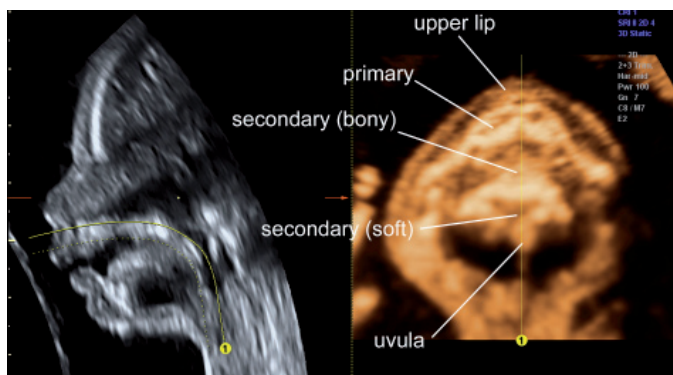


Figure 3: The hard palate and soft palate form a steep angle and therefore can only be demonstrated in a single image by using a curvilinear section. In this, an excellent demonstration of the entire palate is possible: primary palate (or alveolar ridge), bony part of the secondary palate, soft palate and uvula.

## MULTIPLE INDEPENDENT PLANES OF SECTION

Diagnosis of complex anatomy usually requires multiple planes of sections. The ability to obtain planes oriented differently, and if necessary to combine straight and non-straight planes of section is convenient in that one hand it allows to draw very precisely the lines of section, and on the other hand because it allows an efficient documentation. Most frequently, the relevant anatomic information can be stored in one single image.

We have found that this approach is useful in the examinations of the fetal brain, spine and face. Demonstration of normal cerebral anatomy starting with either a standard transabdominal approach or with a transfontanelar approach are displayed in Figures 5 and 6. Remarkable examples of complex anomalies in which one single composite image obtained with Advanced VCI and Omniview is sufficient to provide all diagnostic elements are reported in Figure 7 (intraventricular grade III hemorrhage) and 8 (agenesis of septum pellucidum).

Omniview allows to 'deconstruct' the fetal spine, visualizing independently the three ossification centers (Figure 9). This is particularly useful when dealing with vertebral anomalies such as hemivertebra (Figure 10). Eventually, examples of normal and abnormal facial anatomy are reported in Figures 11-13.

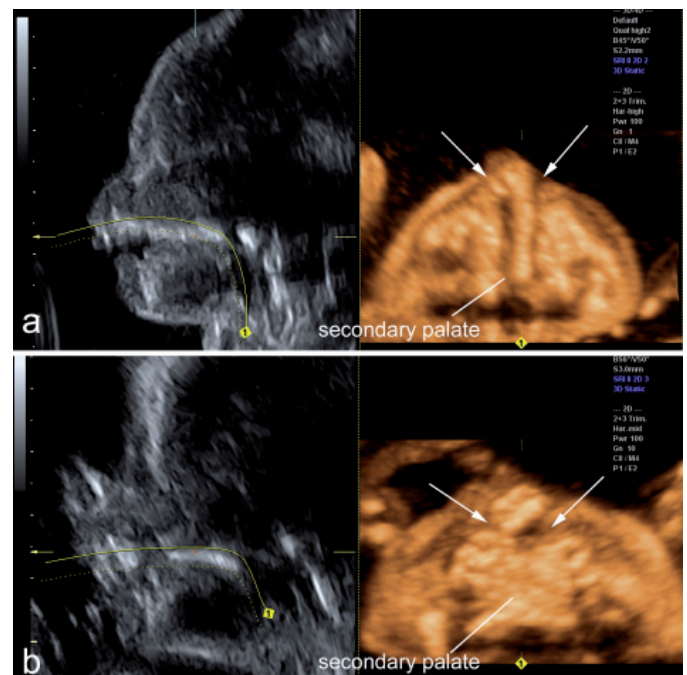


Figure 4: Different types of cleft palate: in a) there is bilateral cleft of the lip and primary palate that is clearly extending to the entire secondary palate; in b) there is a cleft of the upper lip and primary palate, but the secondary palate is intact.

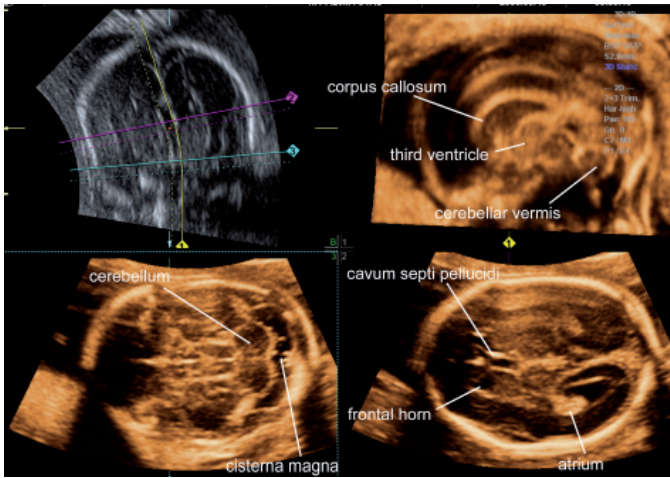


Figure 5: This composite image demonstrate all the anatomic elements that are required for a standard examination of the fetal brain, plus a midsagittal view revealing the corpus callosum. It was obtained with omniview from a volume easily derived from an axial view of the head. The B plane was used to draw the three sections.

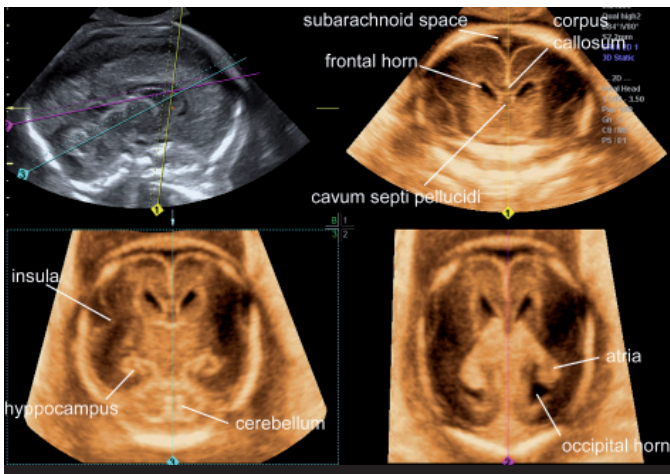


Figure 6: This composite image demonstrate all the anatomic elements that are required for a dedicated transfuntannular neurosonogram. The sagittal plane was used to draw the three sections.

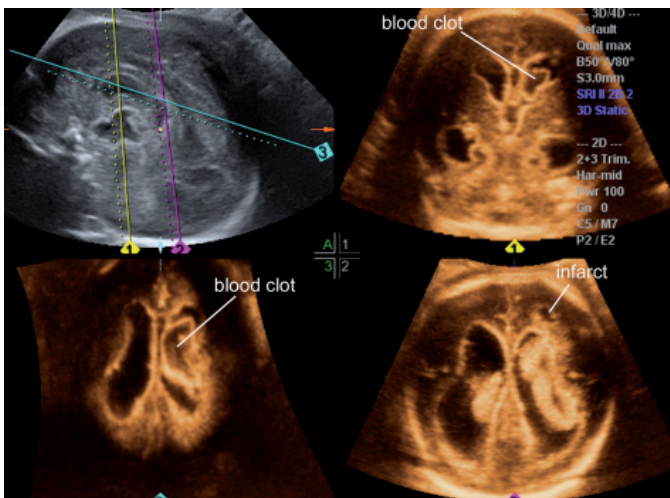


Figure 7: This composite image demonstrates a grade IV intraventricular hemorrhage: ventriculomegaly, a blood clot within the ventricles, and an irregular cystic area in the cortex suggesting a periventricular infarct.

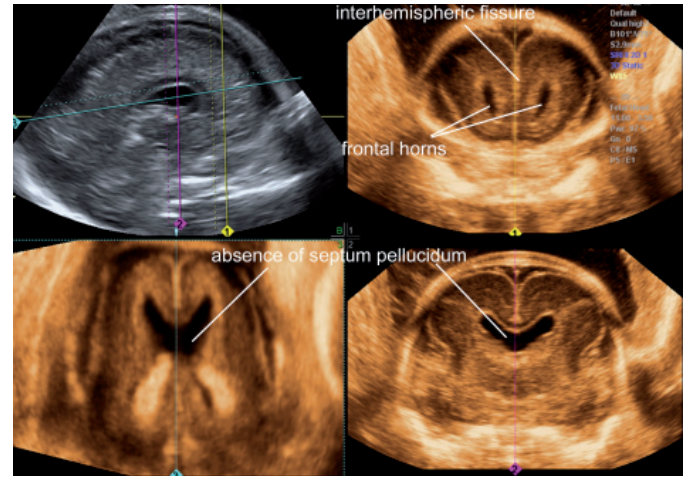


Figure 8: Agenesia of the septum pellucidum: the well formed interhemispheric fissure and anterior separation of the frontal horns allows to differentiate this anomaly from the more severe lobar holoprosencephaly.

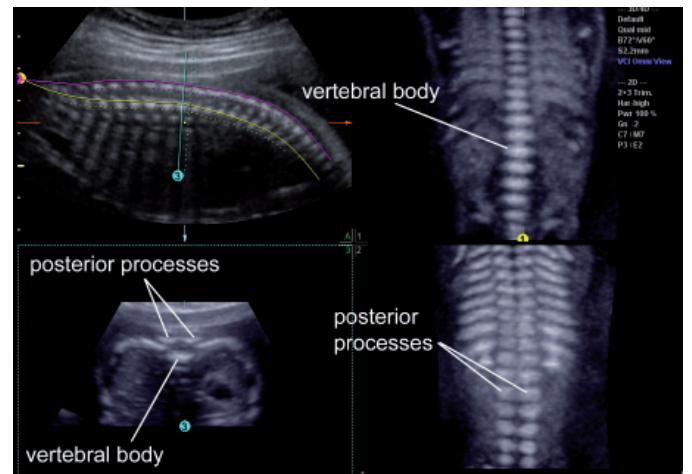


Figure 9: Omniview demonstration of the normal fetal spine. By using thin slices and drawing with polyline tool the contour of the spine it has been possible to clearly demonstrate separate coronal view of each ossification center of the fetal spine. Compare with the abnormal case demonstrated in the following image.

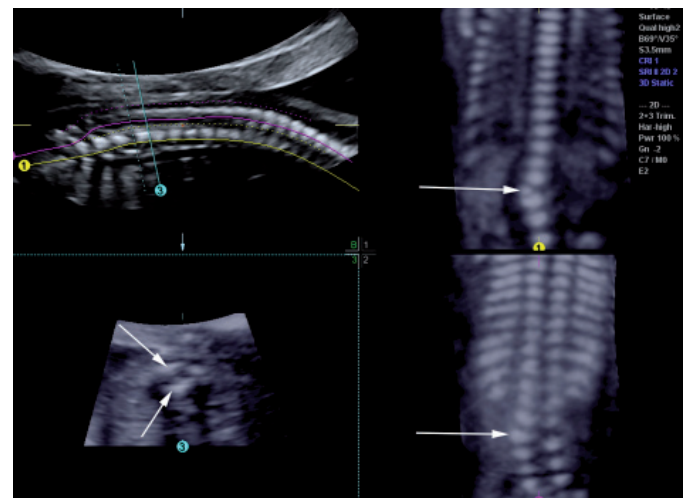


Figure 10: By using the same approach displayed in the previous image, a fetal lateral hemivertebra is clearly demonstrated.

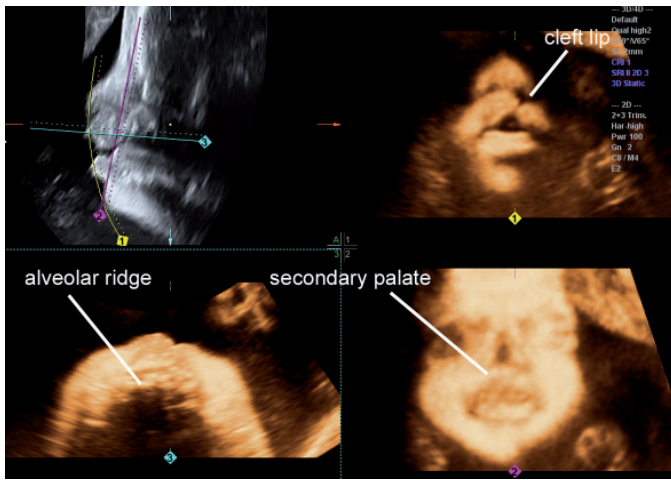


Figure 11: Unilateral cleft lip; the alveolar ridge and primary palate are intact.

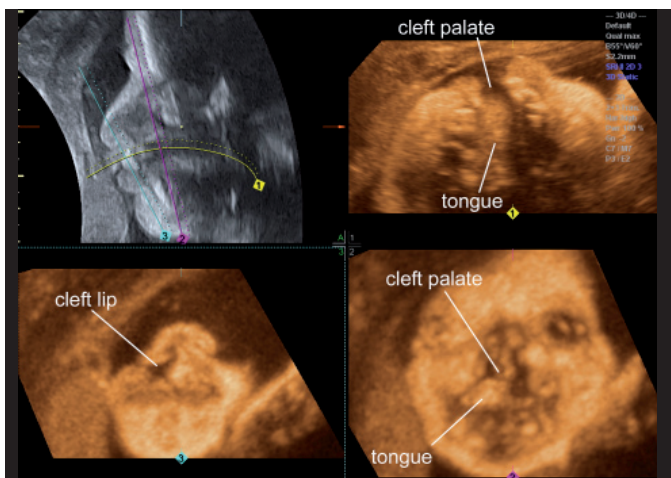


Figure 12: Cleft lip and palate; the lesion is seen extending to the entire length of the posterior palate; the tongue is typically displaced inside the cleft.

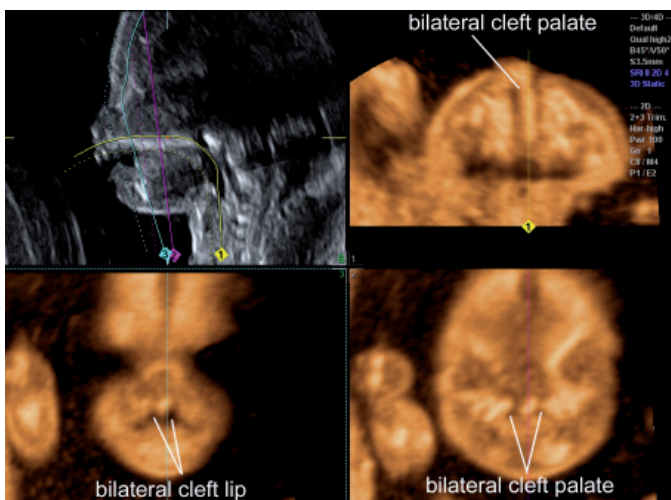


Figure 13: Bilateral cleft lip and palate.

## CONCLUSION

Advanced VCI with Omniview is a promising improvement in 3D sonography. Although the potential is large, we have identified several areas of obstetric and gynecologic ultrasound in which it is particularly convenient: evaluation of the uterus, of the fetal brain, spina and face. We have suggested some modalities of use but of course this tool is extremely flexible and probably most sonologists will develop individual approaches.

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