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The Clinical Practice Review

# RealisticVue™ and CrystalVue™ : a pictorial view in obstetrics practice

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## Abstract

The technological advancement gained by real-time 3D/4D ultrasound allows operators involved in prenatal diagnosis to reconstruct high-quality imaging of embryo and fetus, resembling anatomical reality. Recently, Samsung Medison ultrasound apparatuses have been equipped with two advanced rendering technologies, namely RealisticVue™ and CrystalVue™. The use of these 3D/4D applications enable physicians and sonographers to obtain detailed anatomical information during fetal scan examinations.


## Introduction

The use of 3D ultrasound (3D US) in obstetrics has undergone dramatic development over the past 20 years. Since the first publications on this application in clinical practice, several 3D US techniques and rendering modalities have been proposed and applied to the study of embryo and fetus. 3D US has significantly improved calculations of the volume of fetal organs and limbs as well as estimation of fetal birth weight. Moreover, angiographic patterns of fetal organs and placenta have been assessed using 3D power Doppler ultrasound quantification. Nowadays, the widespread use of 3D/4D US combined with an enhanced scientific background, have contributed to the introduction of these technologies into clinical obstetrics practice, displaying normal anatomy and fetal malformations with high image quality.

In a 3D US examination, the 2D US images are combined by computer to form an objective 3D image of the anatomy and pathology. The further steps are data set acquisition, 3D visualization and image interpretation and/or volume navigation and storage.

Once an anatomical detail elicits investigation, the box representing the “region of interest” is activated and a volume data is acquired. The volume can then be manipulated in all three-orthogonal planes, rendered and reformatted by different modalities through “navigation” within the volume.

The display techniques for 3D US are subdivided into multiplanar, surface-based and volume-based rendering.

3D/4DUS offers the unique possibility to investigate and reconstruct the anatomy in planes not achievable with the use of conventional 2D US. Significant improvement in the 3D US rendering of surface structures have been obtained by a series of recently developed lightening techniques, with impressive imaging through RealisticVue™ and CrystalVue™.

## RealisticVue™

RealisticVue™ uses a 3D/4D US lightening source which allows the orientation of the light to obtain anatomical details more defined and realistic or, in some cases, undetectable with previous technology (Fig. 1).

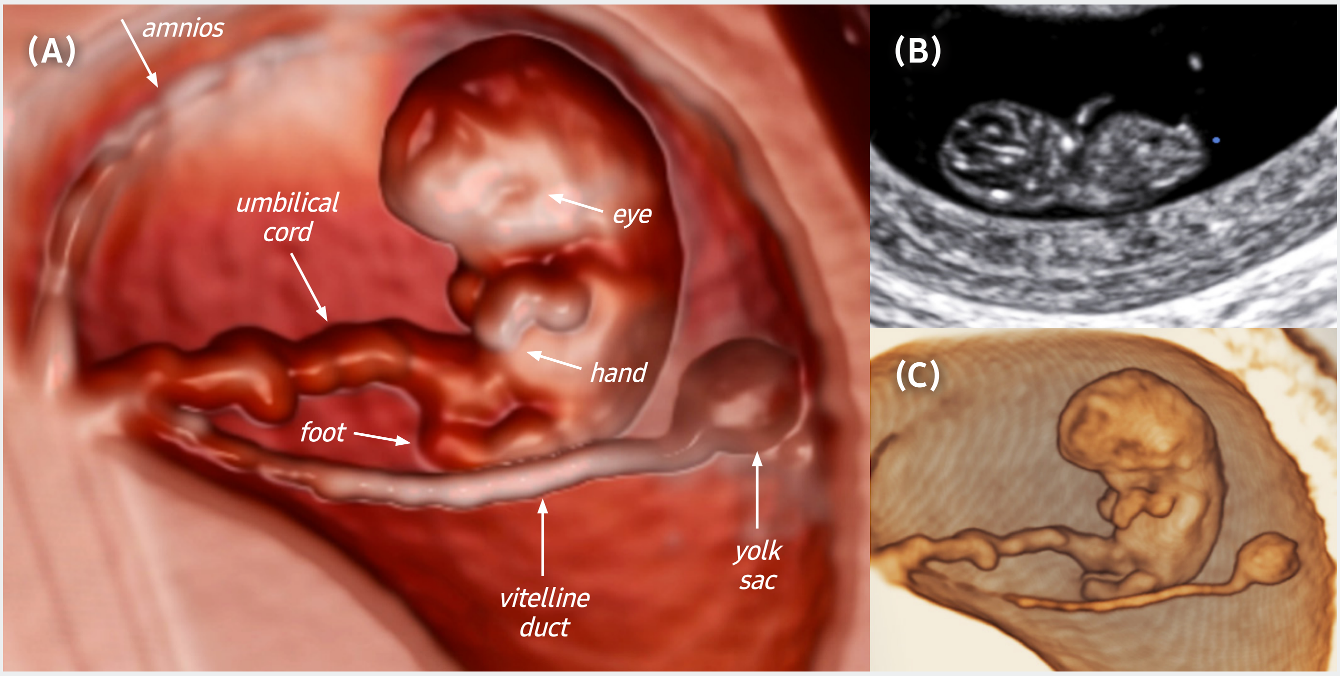


**Figure 1.** Anatomical details of embryo and adnexa at 8 weeks of gestation using RealisticVue™ (A). At 8 weeks, it is possible to visualize the embryo and the embryonic appendages with respect to the classical 2D ultrasound (B), with additional information in the embryological study of early pregnancy (e.g. the limbs and the head) and more realistic and enhanced quality image when compared to the classic surface rendering (C).

RealisticVue™ is activated from the menu setting of the ultrasound apparatus, starting from an acquired 3D volume dataset. The image can be processed until the desired image quality and resolution are achieved (Fig. 2).


**Figure 2.** Setting RealisticVue™ menu showing intuitive and easy instructions: orientation of the light, color and gain can be obtained manually or automatically. It is also possible to activate the "invert" mode application.

Fig. 3 Demonstrates that the rendering of surface structures, such as nuchal fluid can be highly enhanced (A). In addition, by modifying light source orientation and using "invert" mode, the developing brain can be accurately visualized (B). During first trimester of pregnancy, RealisticVue™ has shown to be diagnostic in cases of abnormal pregnancy implantation or in cases of early embryonic malformations (Fig. 4).

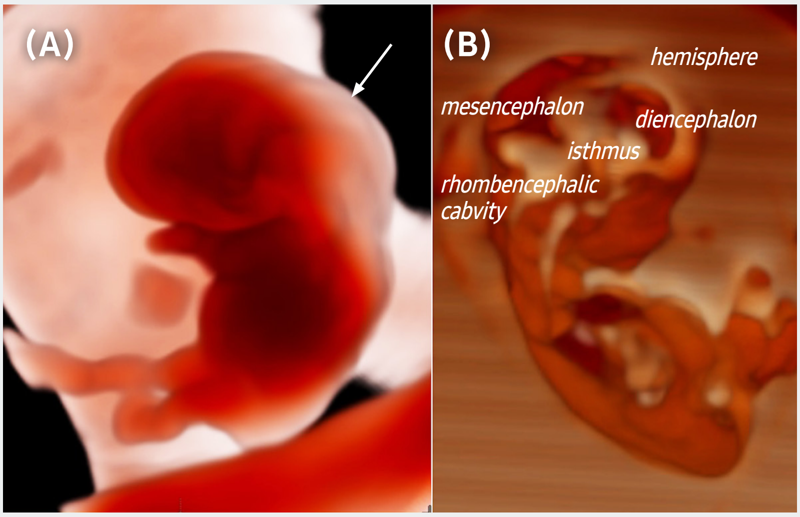


**Figure 3.** Anatomical details of an embryo at 9 weeks of gestation using RealisticVue™: increased retronucal fluid is shown (with arrow) (A). The cephalic pole with intracranial structures are clearly demonstrated (B).

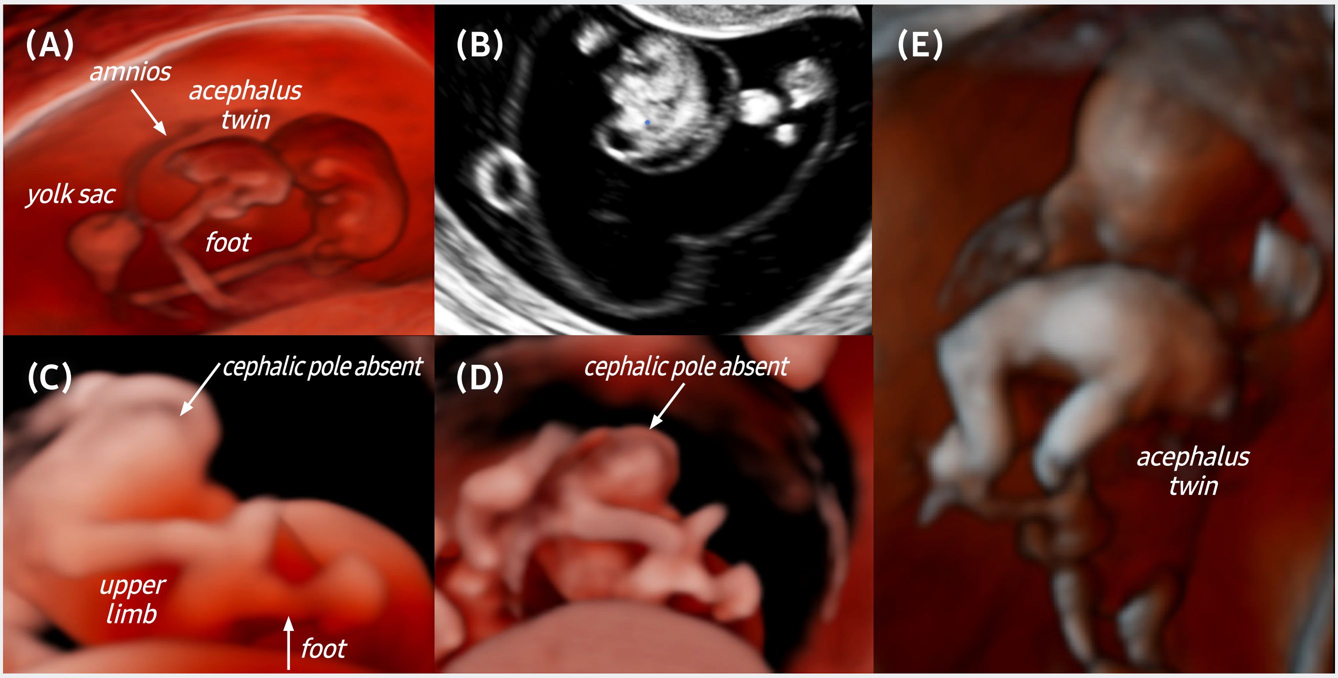


**Figure 4.** A rare case of monochorionic-monoamniotic twin pregnancy with acardiac acephalus co-twin. Note that detection of acrania was possible at very early stage (9 weeks) (A), With the use of conventional 2D ultrasound it could not be possible to recognize the anatomical structures of the embryo (B) while 3D ultrasound and RealisticVue™ rendering made possible to demonstrate the presence of the upper and lower limbs and body of the embryo as well as absence of the cephalic pole (C-D), details of the same case at 11 weeks (E).

During the second and the third trimester, RealisticVue™ adds significant anatomical information in the rendering of the fetal face, fetal profile and limbs, either in normal (Fig. 5) or in pathologic cases (Fig. 6).

**Figure 5.** The second and third trimester of pregnancy: RealisticVue™ rendering of the fetal face and foot.

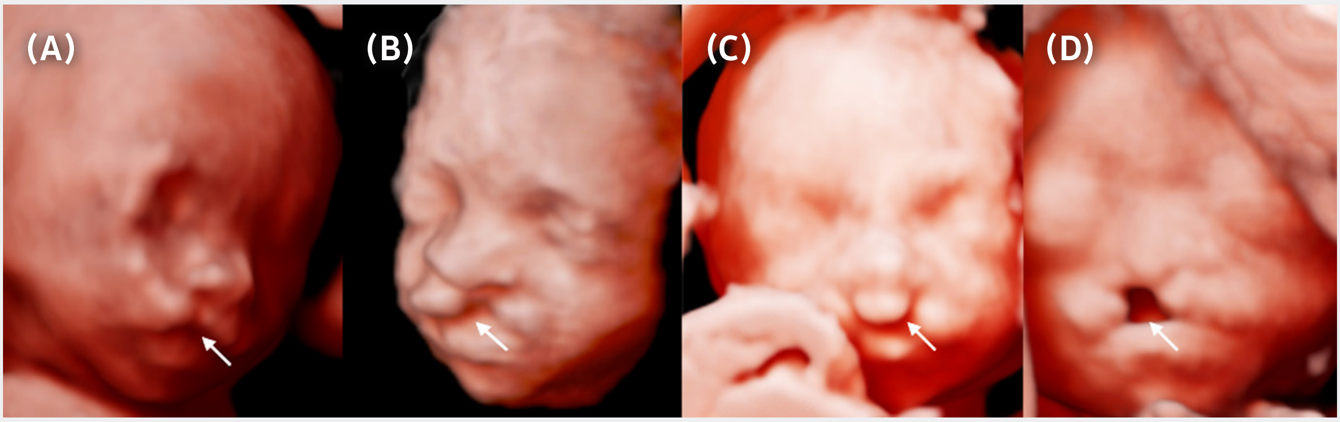


**Figure 6.** A panel of orofacial defects diagnosed using RealisticVue™ in the second trimester of pregnancy: isolated cleft lip (A), unilateral cleft lip and palate (B), bilateral cleft lip and palate (C), median cleft lip and cleft palate with agenesis of the nose (D).

Notwithstanding difficult details to be detected using 2D US, the soft palate and the uvula can now be shown by RealisticVue™ with impressive image quality (Fig. 7A), This in some cases, enabled the demonstration of the extension of cleft posterially to involve the soft palate or the uvula (Fig. 7B).

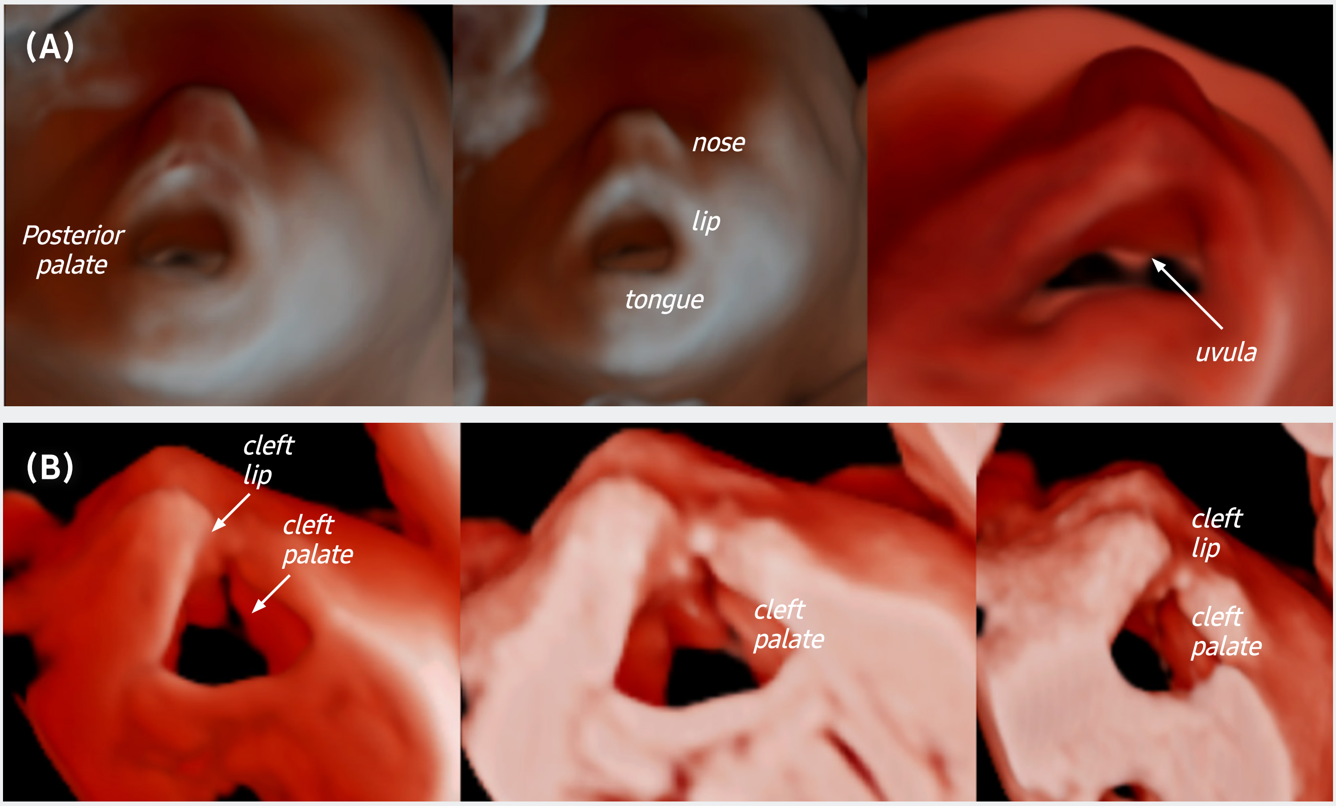


**Figure 7.** Visualization of the oral cavity, palate and uvula in a fetus with normal anatomy (A). Visualization of the oral cavity in a fetus with cleft lip-palate malformation (B).

Using RealisticVue™, realistic perception of the fetal anatomy is increased and associated with an easier parental bonding process. As a consequence, it may facilitate the genetic counseling in cases of fetal malformations.

Pioneering implication of the introduction of RealisticVue™ may be represented by thorough study of the abnormal fetal phenotype, improving our knowledge about genetic or non-genetic syndromes, especially those associated with fetal dysmorphisms.

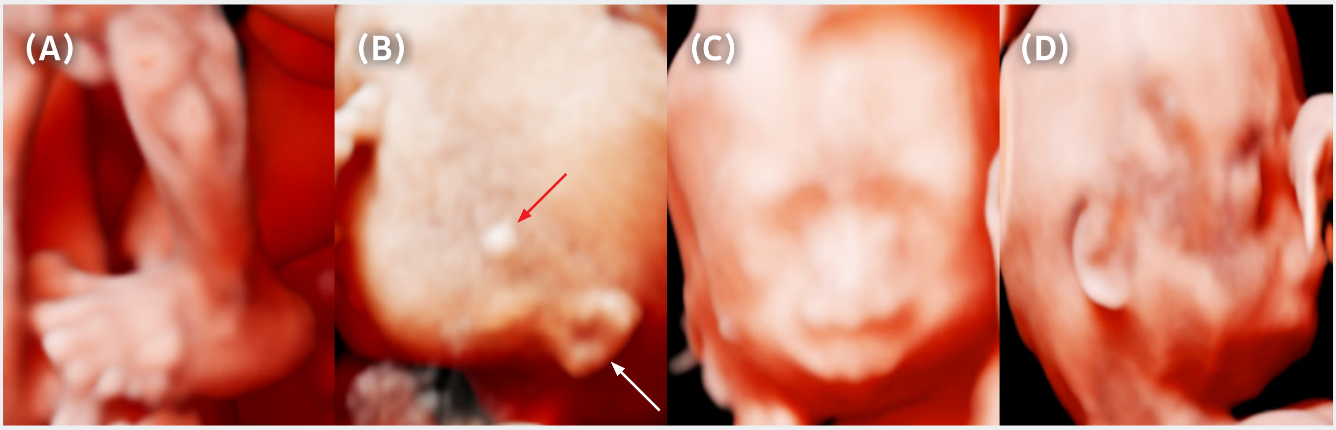


**Figure 8.** Multiple fetal dysmorphisms: polydactyly (A), microthia (white arrow) and skin-tag (red arrow) (B), micrognathia (C-D).

## CrystalVue™

The quality of the rendering obtained with RealisticVue™ is enhanced by applying a second software, namely CrystalVue™. This latter technique allows visualization of the anatomical details in "transparency" mode, with the ability to differentiate between different tissues e.g. bony or cartilage structures or vascular branching or parenchimatous organs, adding information when compared with the use of RealisticVue™ alone.

CrystalVue™ allows the operator to select different setting from the same volume: complexity, strength and transparency in order to obtain multiple images and allowing different information in relation to the anatomical detail selected (Fig. 9).

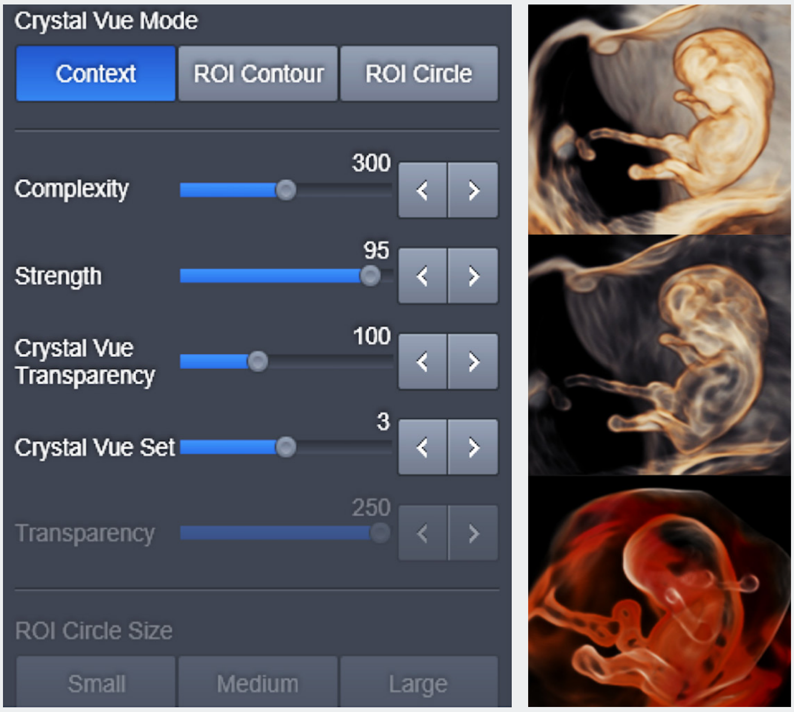


**Figure 9.** Settings of CrystalVue™ menu showing intuitive and easy instructions. Orientation of the light, color and gain can be obtained manually or automatically.

In our hands, CrystalVue™ has proved to be useful throughout all trimesters, either in normal or in pathologic cases.

## First trimester of pregnancy

Using CrystalVue™ in combination with RealisticVue™, the location of the gestational sac in a case of Mullerian anomaly or in a case of ectopic intrauterine implantation could be precisely detected. In particular, the CrystalVue™ rendering on coronal plane, which is not detectable by means of 2D US, enabled a contemporary imaging of both uterus and gestational sac (Fig. 10). Visualizing the coronal plane is useful in early stage pregnancy for several reasons. First, many patients are unaware that they are carriers of mullerian malformations before pregnancy and therefore the diagnosis allows a correct stratification of the risk related to the patient's malformation. Secondly, in case of abortion or termination of pregnancy, curettage could be performed in the empty cavity without terminating the pregnancy.

By applying CrystalVue™, it is possible to obtain highly defined anatomically realistic images of diagnostic quality for these conditions.

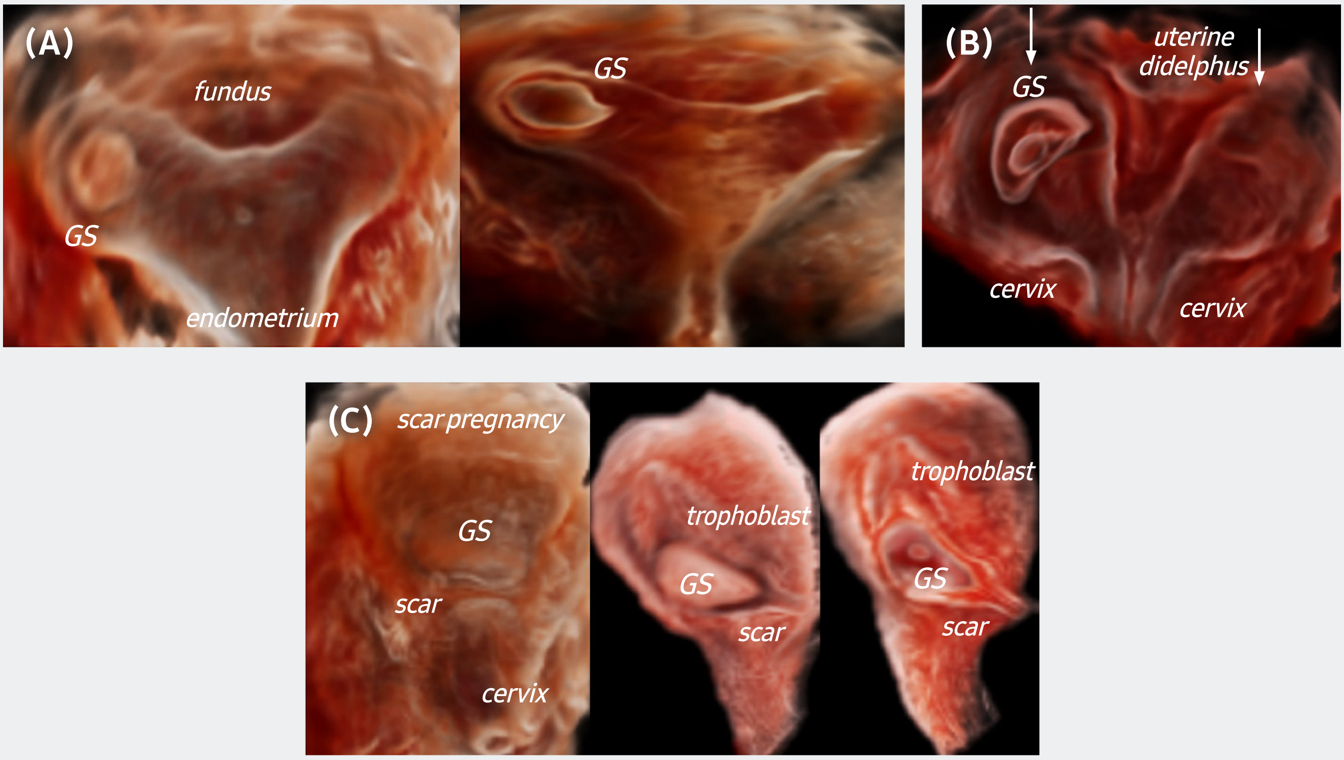


**Figure 10.** Intrauterine pregnancy is diagnosed at 5 weeks of gestation in an arcuate uterus using transparency mode (A). Intrauterine pregnancy at 6 weeks located in the right horn in a case of Mullerian anomaly (note doubled cervix: white arrows) is seen (B). Scar pregnancy (GS: gestational sac) diagnosed at weeks of gestation in a mother with previous C-section. Anatomical relationship of the trophoblast with the scar are well visualized (C).

From 7 to 8th week's gestation, it has been possible to reconstruct the embryo at early Carnegie stages with high fidelity, empowering the study of sonoembryology (Fig.11, Fig.12).

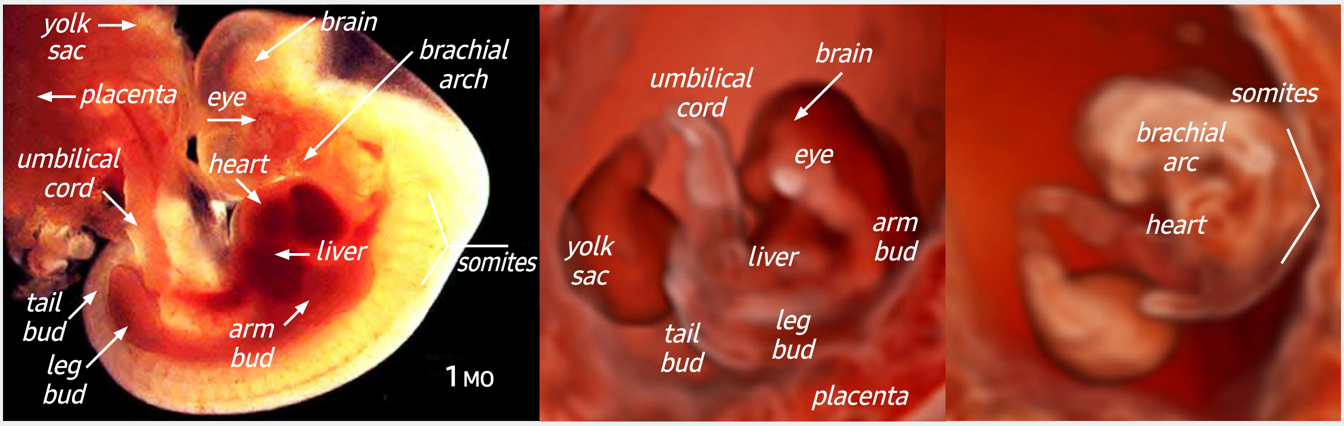


**Figure 11.** Sonoembryology: comparison between ultrasonography and human embryo at 7 weeks of gestation.

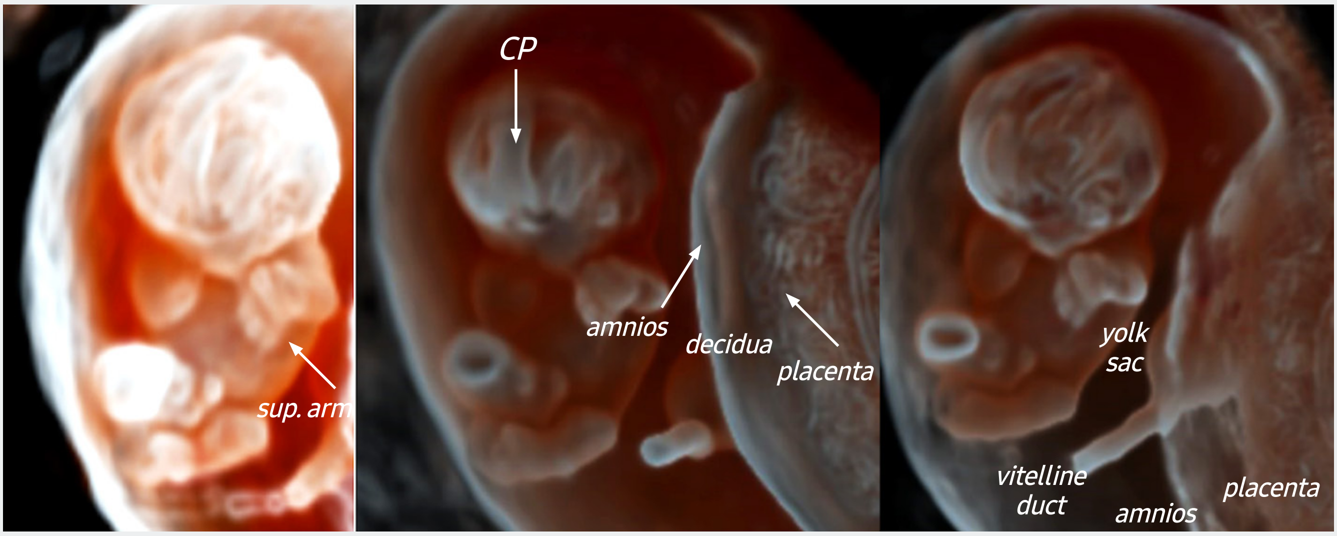


**Figure 12.** Sonoembriology: Using CrystalVue™, it is possible to visualize the embryonic adnexa and the cartilage structures within limbs formation since the 8th week of gestation.

Legend: CP (choroid plexus).

## Brain and spine

CrystalVue™ is extremely accurate in reformatting the developing fetal brain on a mid-sagittal plane, starting from 3D US volume acquired on an axial plane. Snapshot of the corpus callosum and cerebellar vermis are displayed in a manner that resemble those obtained with neonatal transfontanellar 2D US (Fig. 13).

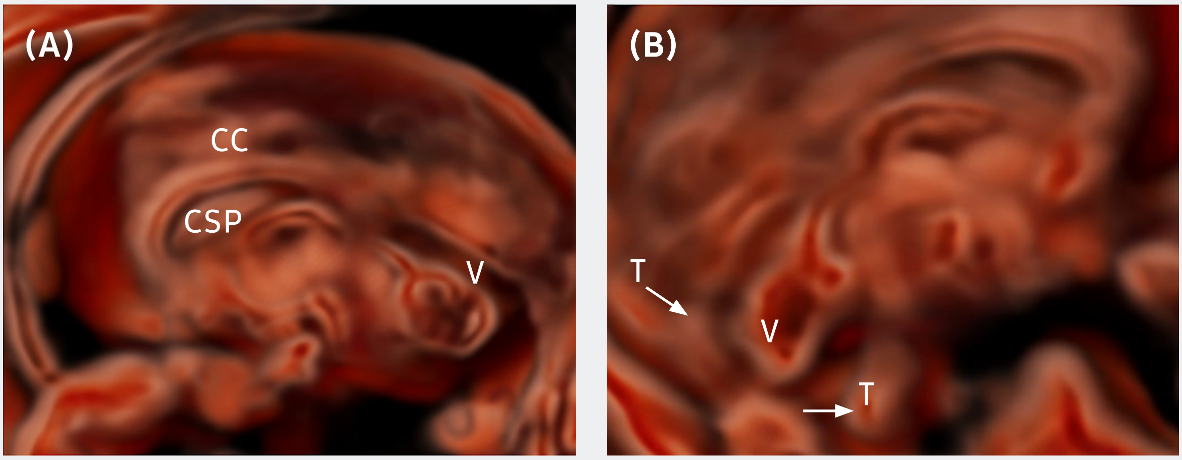


**Figure 13.** Reconstruction of the fetal brain using CrystalVue™ on a sagittal plane. The corpus callosum (CC) is outlined between the superior aspect defined by the fornix and the inferior aspect limited by the superior portion of the cavum septum pellucidum (CSP) (A).

Posterior cerebral fossa: details of the cerebellar vermis (V) and its spatial relationship with the encephalic trunk (T, arrowhead) and insertion of the tentorium (t, arrow) in a case of Blake's pouch cyst (B).

By applying CrystalVue™, it is possible to obtain highly defined anatomically realistic images of diagnostic quality for these conditions.

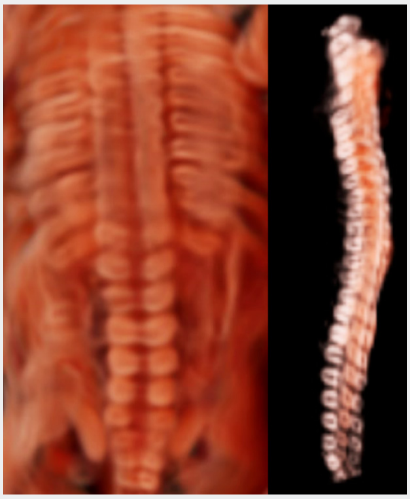

**Figure 14.** Fetal spine reconstructed using CrystalVue™.

Thanks to transparency mode, the neural canal with the spinal cord can be visualized with reliable accuracy, providing more realistic images of the vertebral defect (Fig. 15).

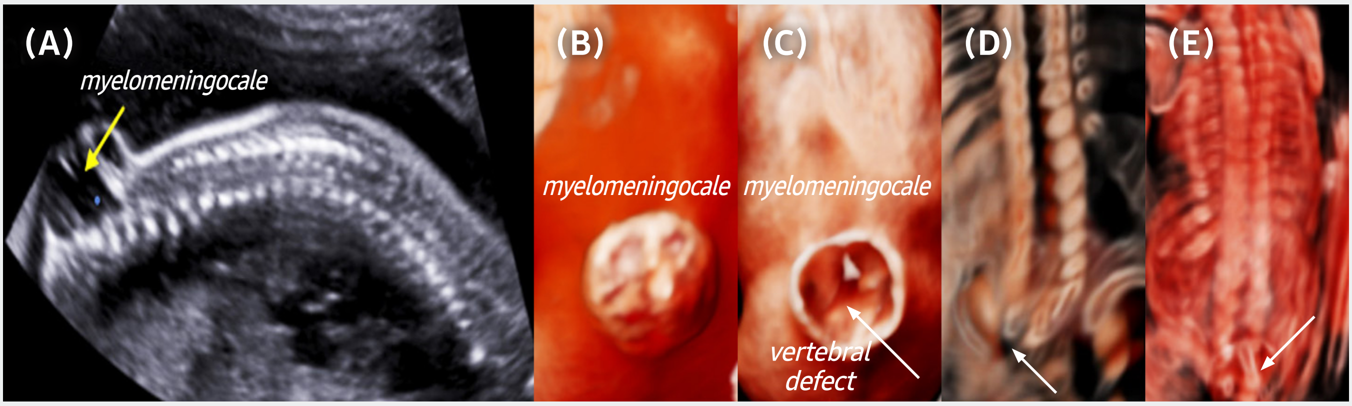


**Figure 15.** Open spina bifida : 2D ultrasound clearly visible the vertebral defect whit myelomeningocele in the sagittal scan ( A), CrystalVue™ with different complexity: defect of the spine in which part of the spinal cord and meninges (white arrow) are exposed through a gap in the backbone (B-E).

## Fetal face

As already shown, the combined use of RealisticVue™ and CrystalVue™ in all three orthogonal planes add additional information in the evaluation of normal anatomy and orofacial defects, clarifying the anatomical relationship between surface and bony structures (Fig. 16-19).


**Figure 16.** The second trimester of pregnancy: CrystalVue™ rendering of the normal fetal face and palate.

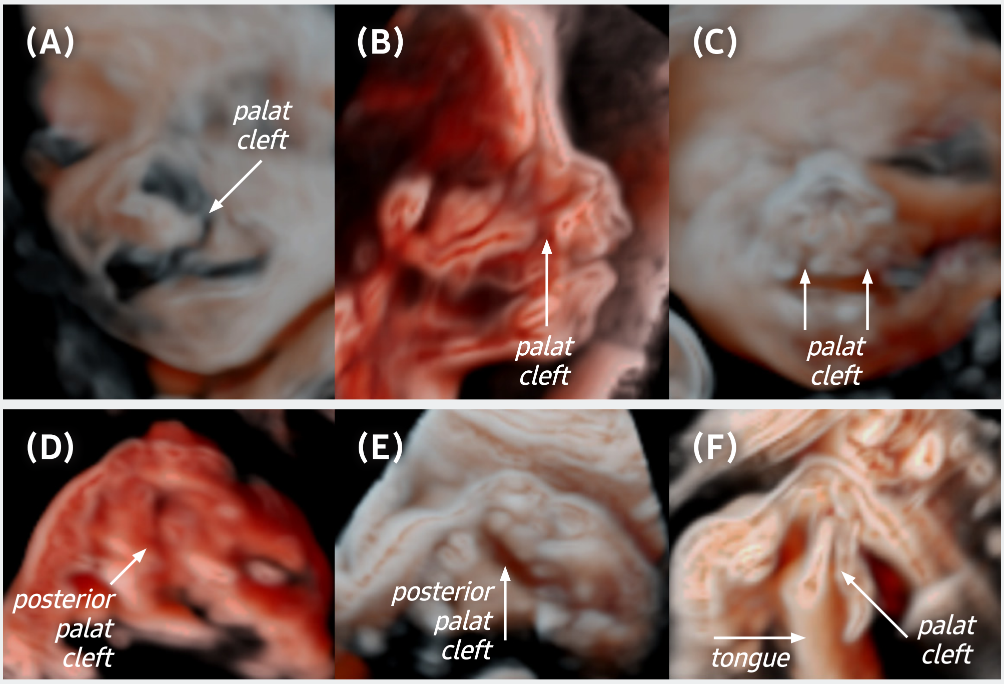


**Figure 17.** The second trimester of pregnancy: CrystalVue™ rendering of lip-palate cleft. CrystalVue™ rendering on coronal plane: the cleft of the hard palate is clearly visible (white arrow) (A), CrystalVue™ rendering on sagittal plane: cleft of the hard palate (white arrow) (B), CrystalVue™ rendering on coronal plane: bilateral cleft of the hard palate (white arrow) (C), CrystalVue™ on axial plane: cleft of the hard and soft palate (arrows) (D-F).

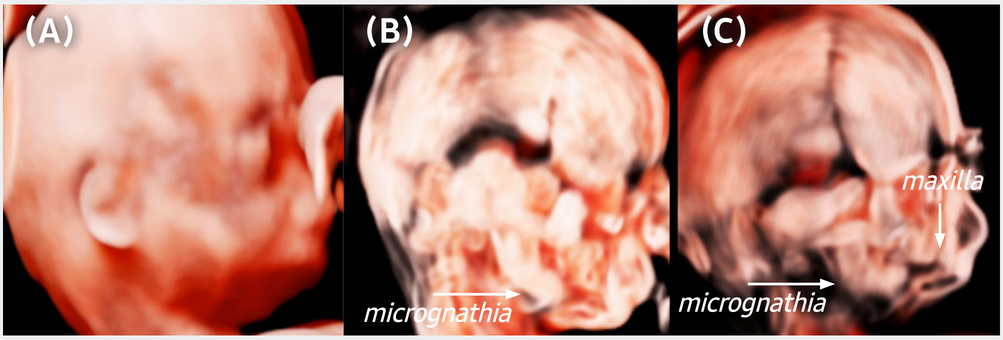


**Figure18.** Comparison between RealisticVue™ and CrystalVue™ in fetus with micrognathia. In using CrystalVue™, the jaw in its entire length can be visualized and compared with the maxilla.

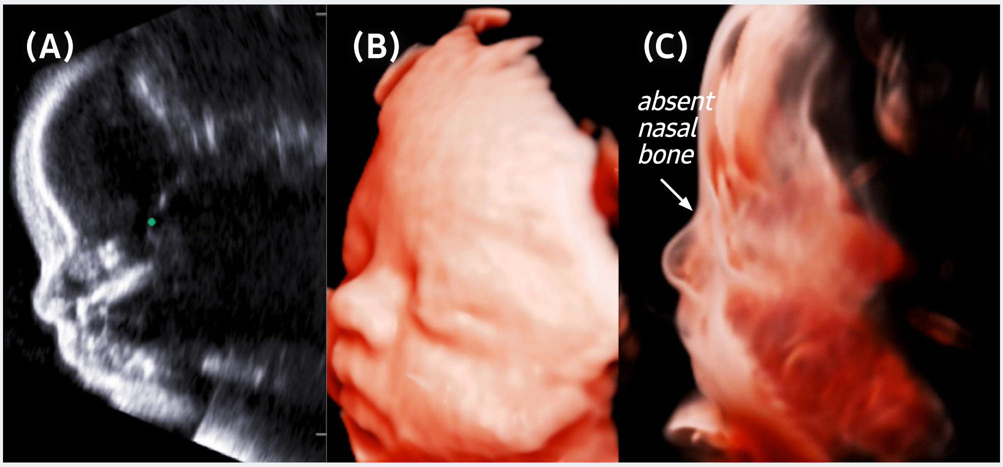


**Figure 19.** Fetus in the third trimester with trisomy 21: image of the fetal face in 2D ultrasound (A), RealisticVue™ rendering (B), CrystalVue™ rendering (C). Note that image (C) is the only case where absence of the fetal nasal bone is clearly visible.

## Limbs

CrystalVue™ images itself may hold diagnostic information in the study of the upper and lower limbs, allowing accurate definition of small digit defects like those seen in case of phalanx agenesis or syndactyly, sometimes undetected using conventional 2D US or using previous 3D US software (Fig.20).

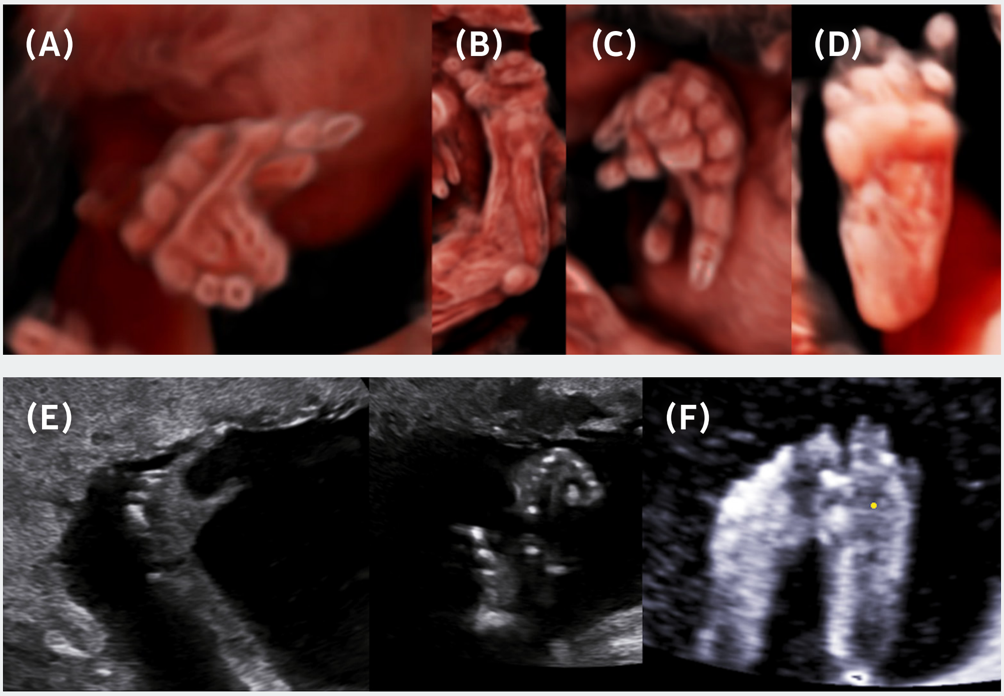


Figure 20. CrystalVue™ rendering: malformations of the fingers and toes (A-D) compared with 2D ultrasound (E-F)

## Thorax and abdomen

The use of CrystalVue™ may be helpful in the study of the upper and lower fetal airways. The dividing bronchi and esophagus can be rendered, especially on coronal plane (Fig. 21).

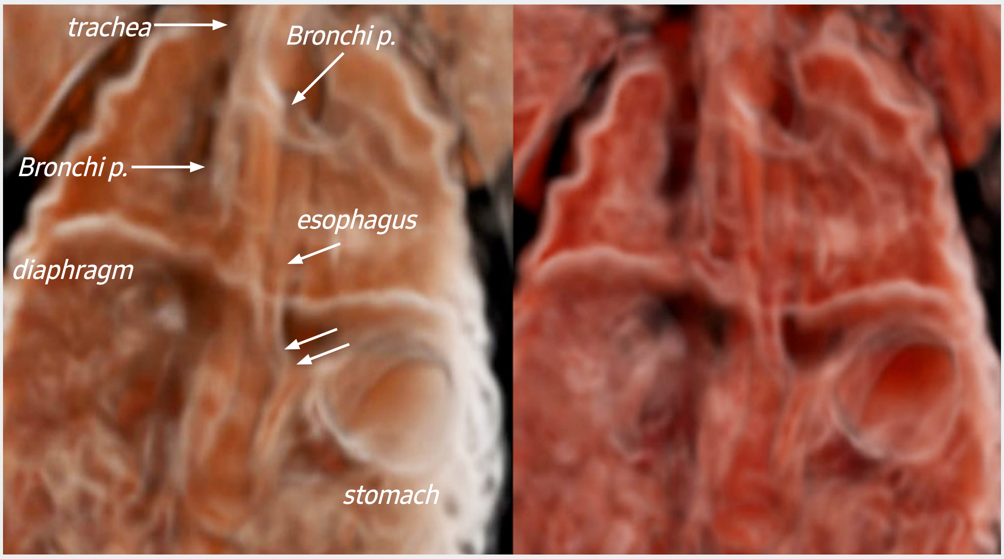


Figure 21. CrystalVue™ rendering of the chest and abdomen.

In selected cases, the use of “invert” mode is recommended to gain better imaging definition of hollowed organs, in both normal and pathologic cases (Fig. 22-24). Future research area of interest should focus on angiographic study of intrahepatic vessels and those of the great arteries.

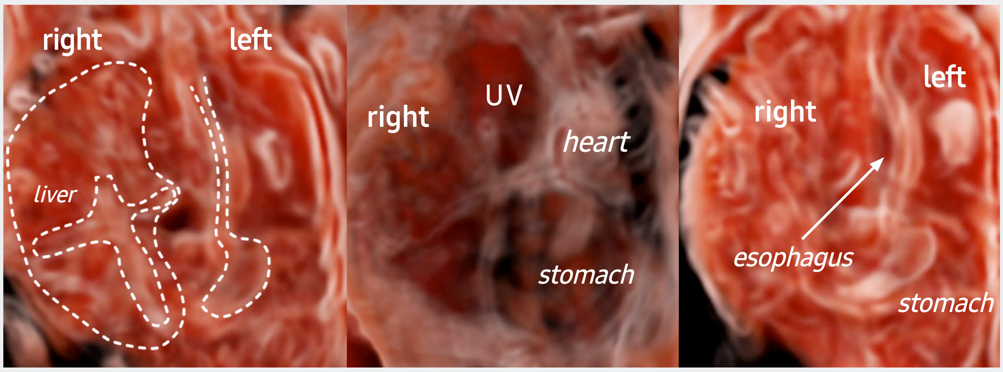


**Figure 22.** Isolated right diaphragmatic hernia, dislocation of the esophagus (arrow), heart, liver and umbilical vein (UV) in the chest.

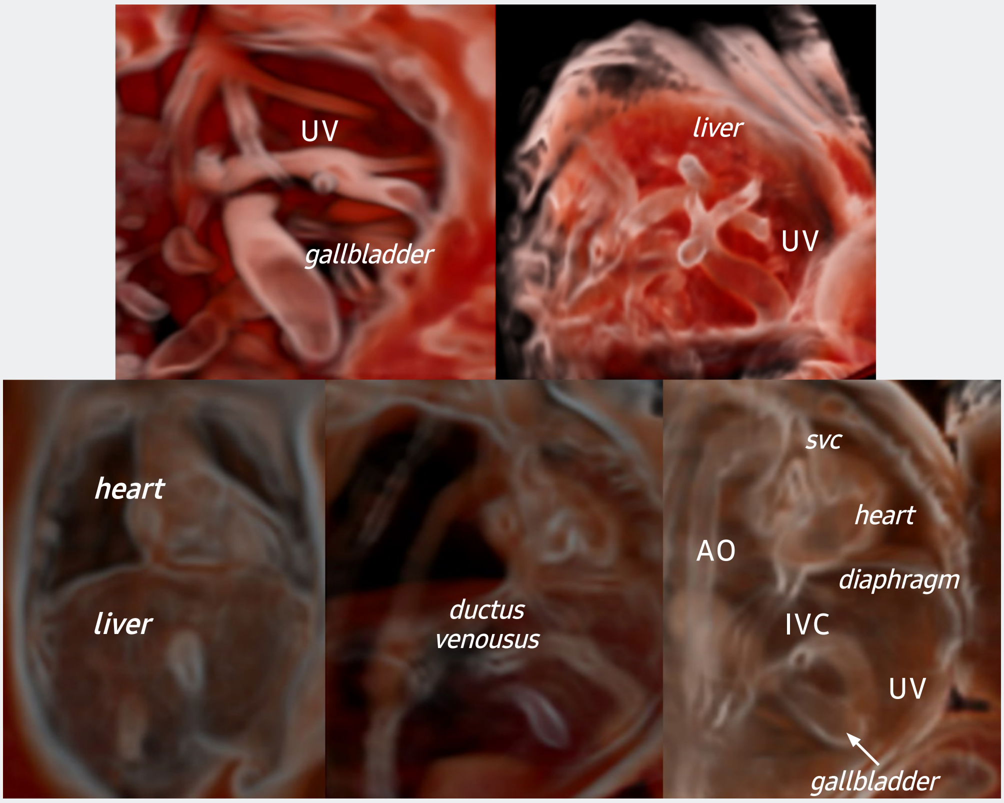


**Figure 23.** CrystalVue™ rendering of the thoracic and abdominal organs and vessels.
Legend: UV(umbilical vein), AO(aorta), SVC(superior vena cava), IVC(inferior vena cava)

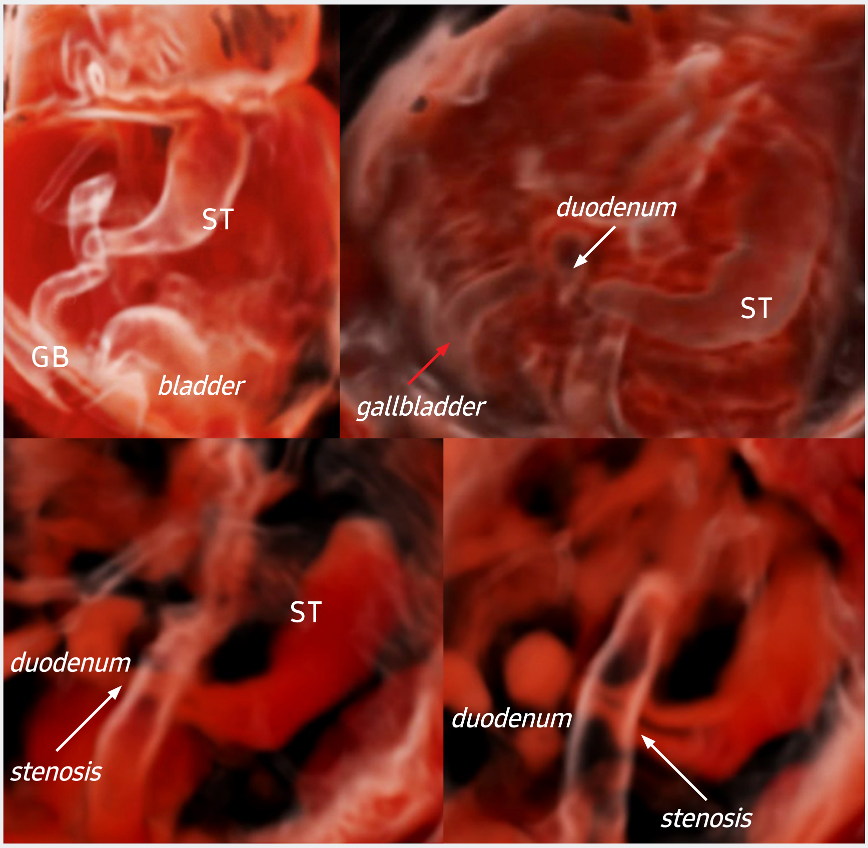


**Figure 24.** CrystalVue™ rendering: duodenal stenosis (whit arrow) (ST: stomach, GB: gallbladder (red arrow).

## Conclusion

The development of lightening techniques RealisticVue™ and CrystalVue™, are a milestone in the technological advancement of modern ultrasound equipment, especially when such technology is applied to obstetrics practice. We anticipate a surge in the clinical use of these software, now available in Samsung Medison's ultrasound systems. The uptake of these techniques will be accelerated by it's ease of use, intuitive toolbar and short learning curve. The impressive and high definition snapshots of the fetus, closely resembling reality, obtained with the combined application of RealisticVue™ and CrystalVue™ may add substantial information over conventional rendering mode, improving the antenatal diagnosis of fetal malformations.

## Supported Systems

- WS80A

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