

ADVANCED 3D / 4D IMAGING



HERON WERNER JR
PEDRO DALTRO

Model of a human
fetus at 32 weeks



ADVANCED 3D / 4D IMAGING



In the past 12 months, I have had no relevant financial relationships with the manufacturer(s) of any commercial product(s) and/or provider(s) of commercial services discussed in this CME activity.

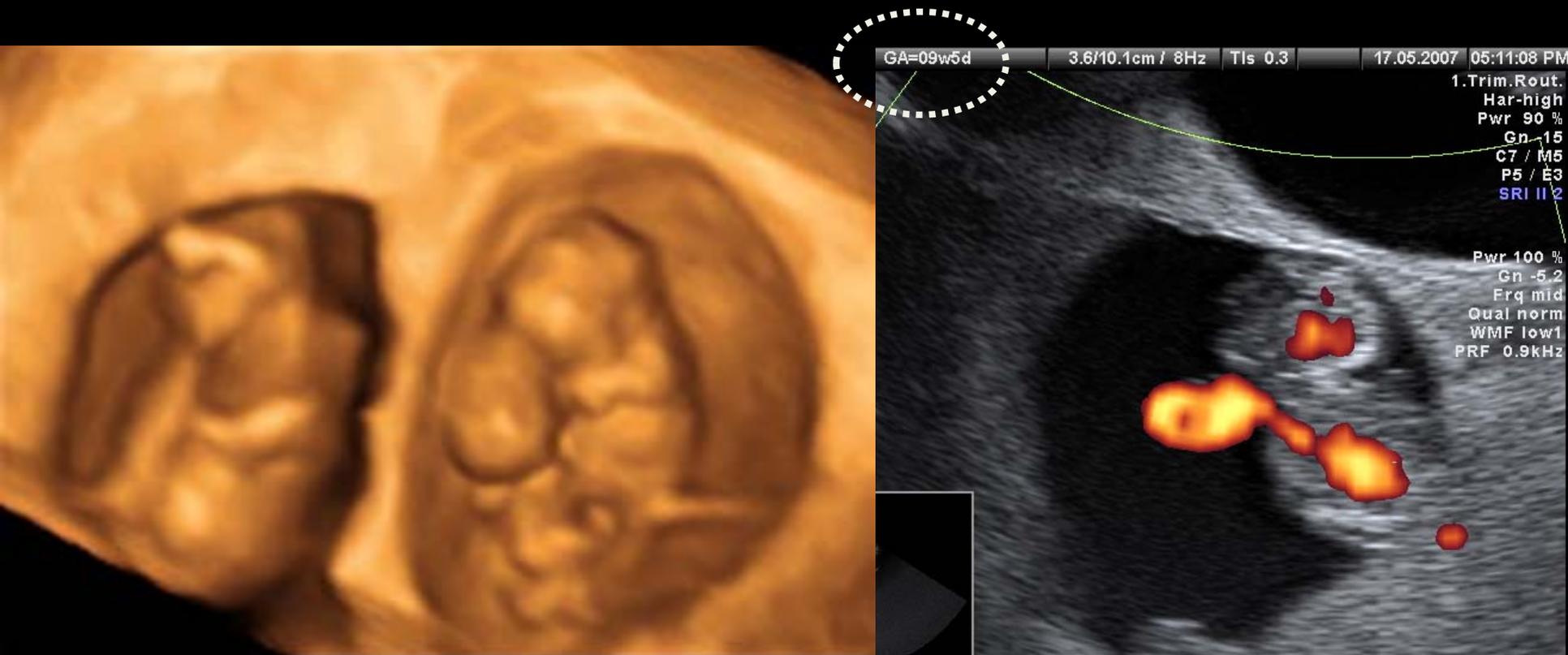
I do not intend to discuss an unapproved/investigative use of a commercial product/device in my presentation.

ULTRASONOGRAPHY



- **Increased availability**
 - **Low cost**
 - **Security**
 - **Good sensitivity**
- **Capacity of analysis in real time**

- Twin pregnancy after IVF. Two embryos were transferred, but we can see 3 embryos because one embryo had an incomplete division into two (thoracopaguses).



36850-08-03-26-23 GA=11w4d

6.5cm / 21Hz

TIs 0.1

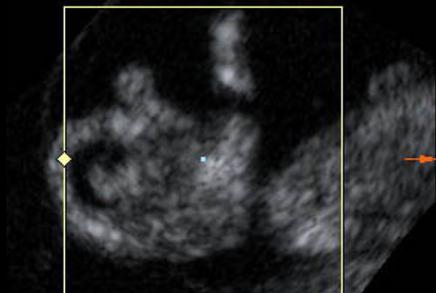
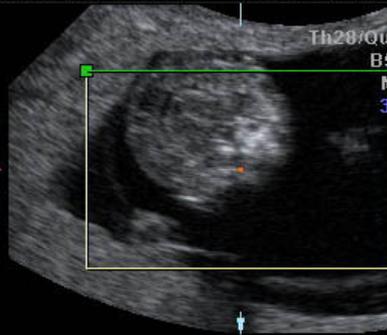
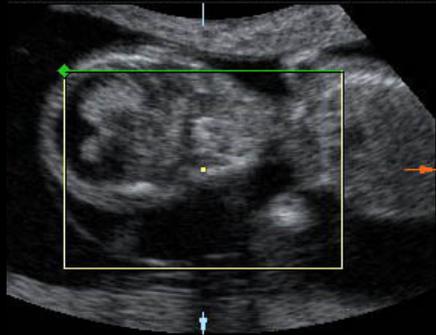


36850-08-03-26-23 GA=11w4d

1.2/4.4cm / 37Hz

TIs 0.1

26.03.2008 16:3



ALOBAR HOLOPROSENCEPHALY



36850-08-03-26-23 GA=11w4d

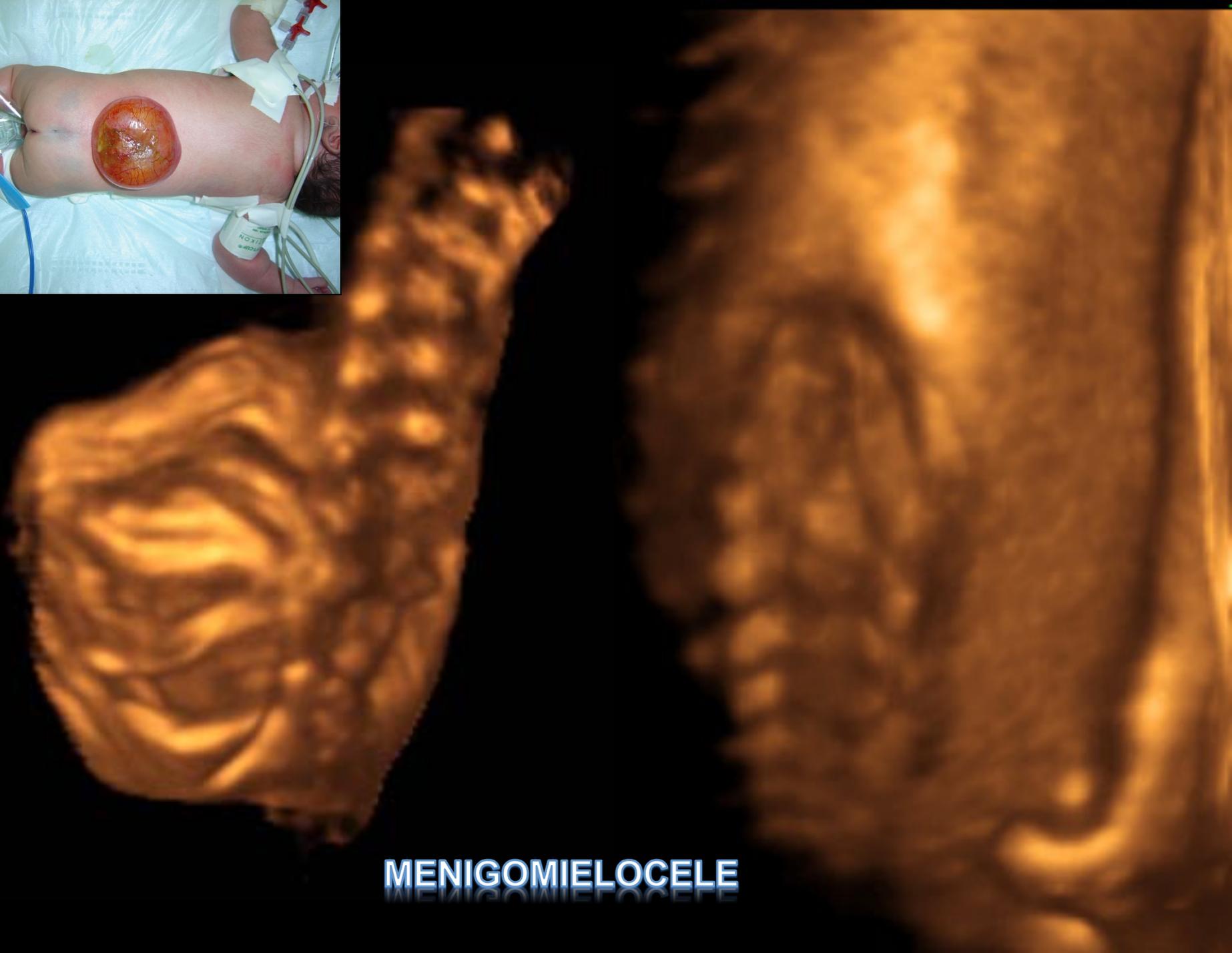
1.2/ 4.4cm / 37Hz

TIs 0.1





MENIGOMIELOCELE





Exencephaly



Microphthalmia



Bilateral cleft lip



Anencephaly

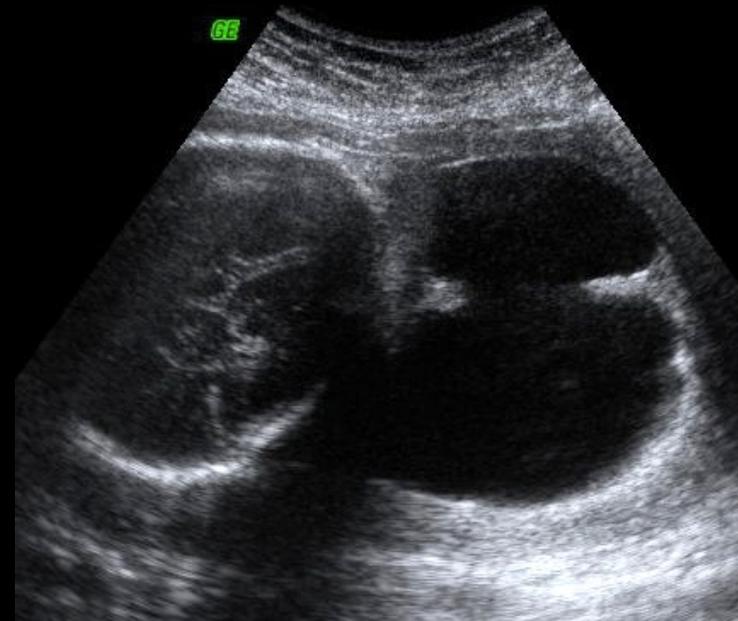
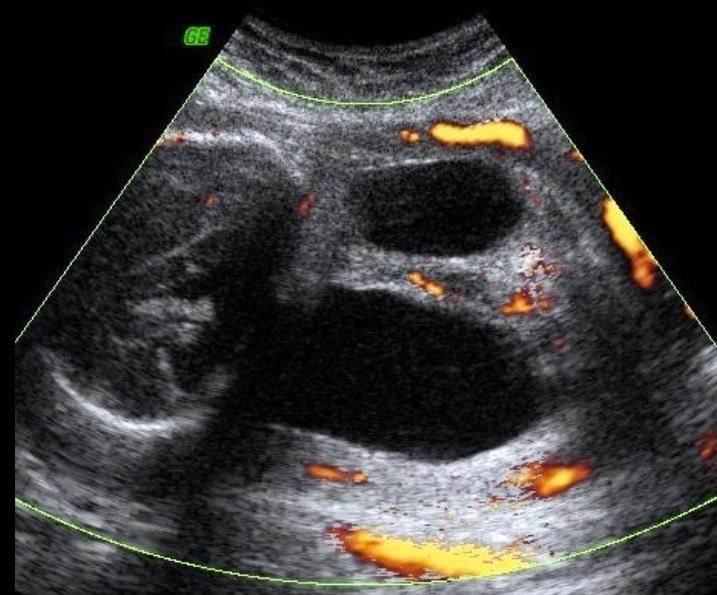
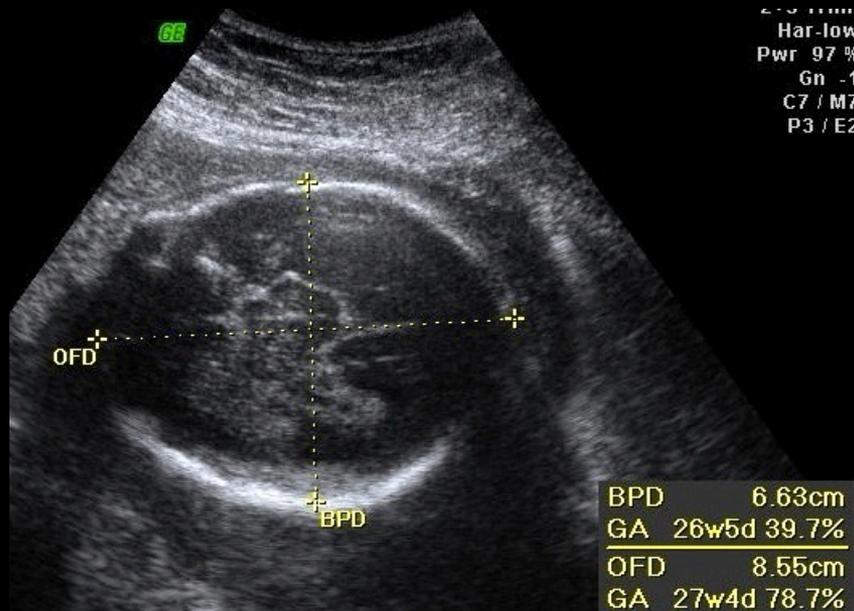


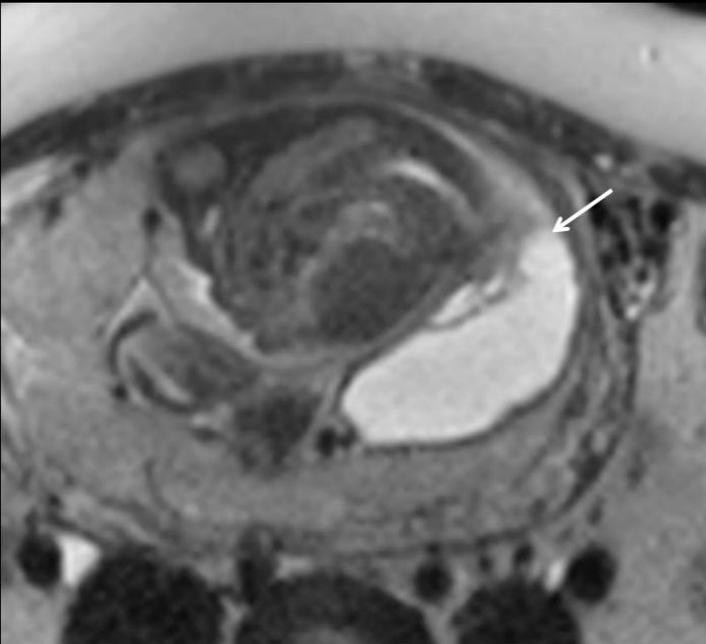
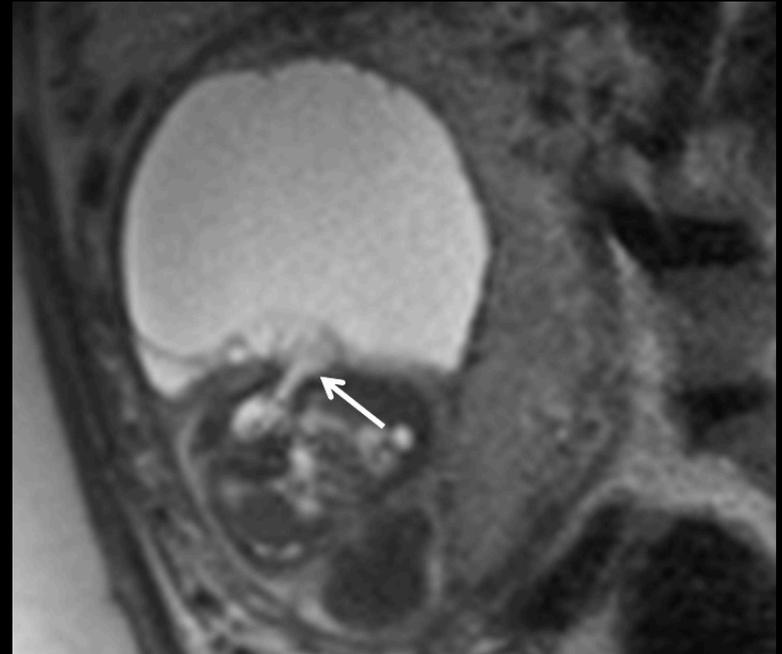
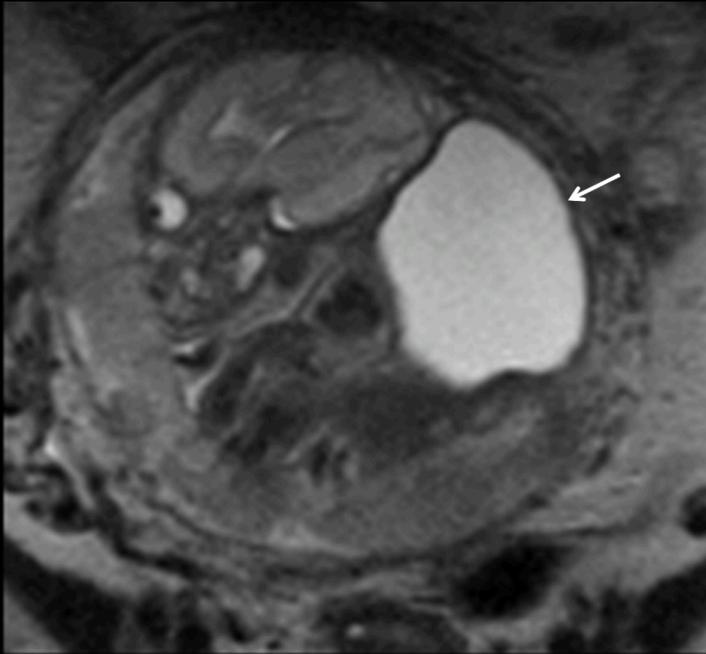
Retrognathia



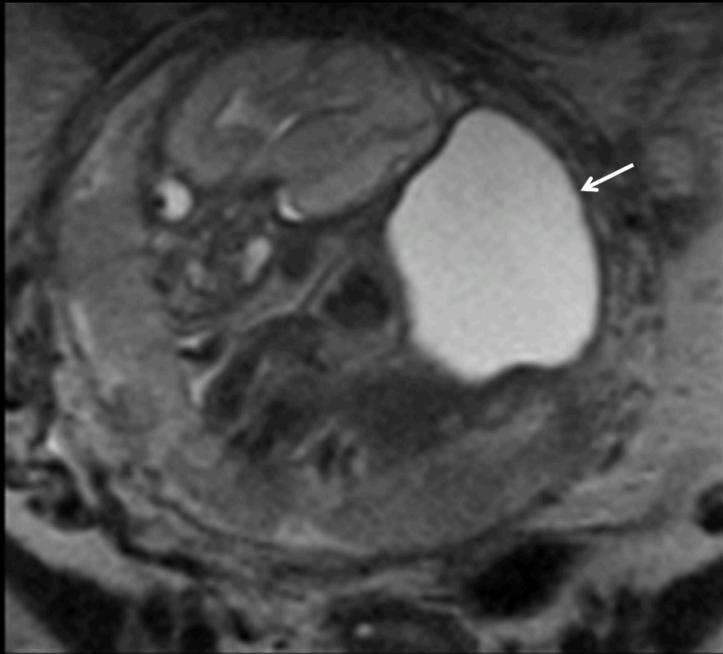
Tongue protrusion

➤ 27 weeks, adramnia. Cystic cervical mass?

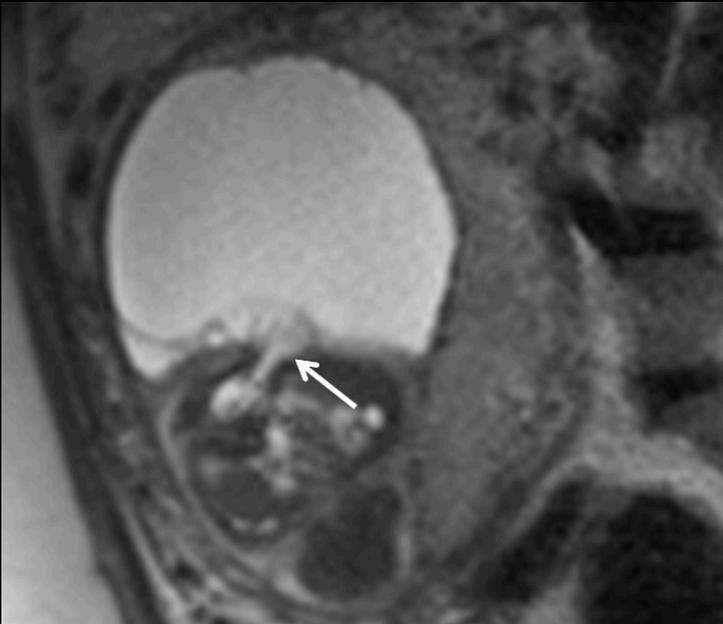




- MRI shows the origin of mass in the final column.
- Also not being displayed lower limb.



- The mass appeared cervical due to the anomalous position (Adramnia).
- Bilateral Renal Agenesis.
- Caudal Regression Syndrome.



MAGNETIC RESONANCE IMAGING



Study of the Fetus:

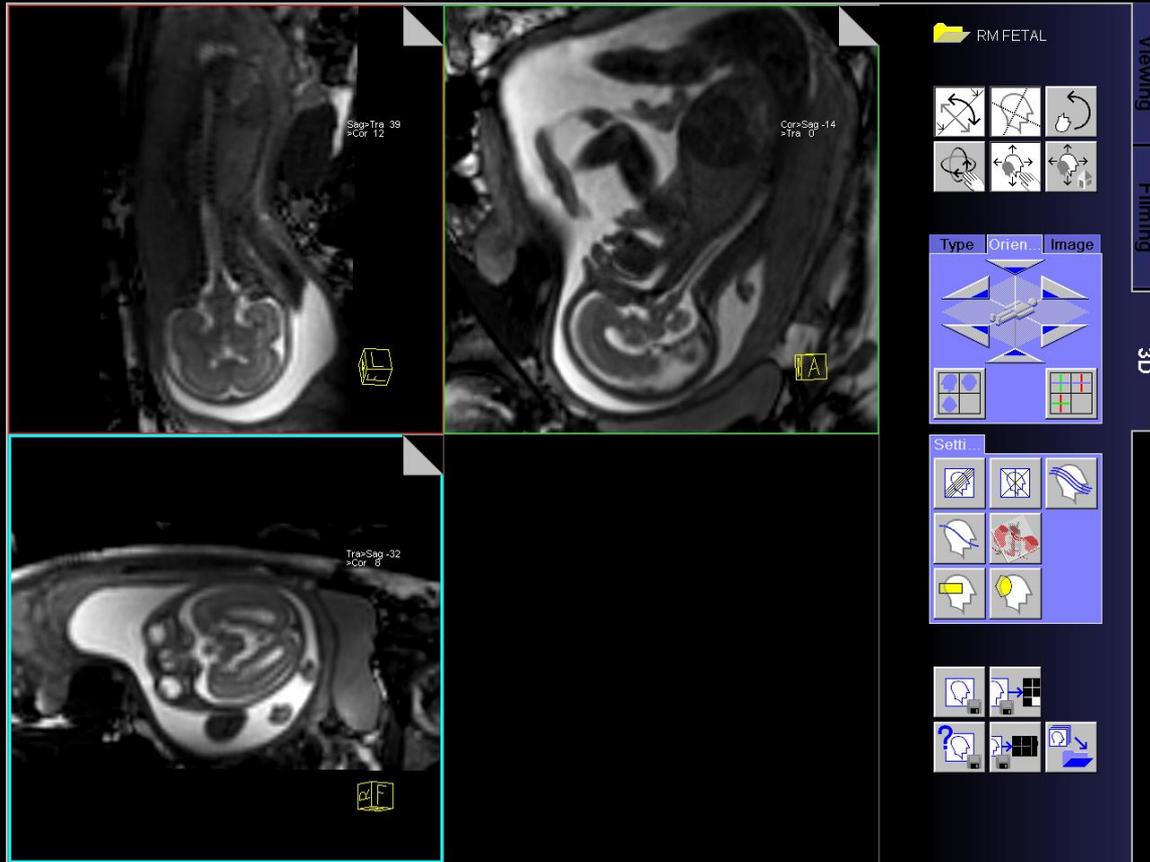
- **multiplanar capability**
 - **contrast tissue**
- **No ionizing radiation**

Smith FW et al.: MR imaging in pregnancy. Lancet, 1983; 1(8314-5):61.

ISOTROPIC SEQUENCE

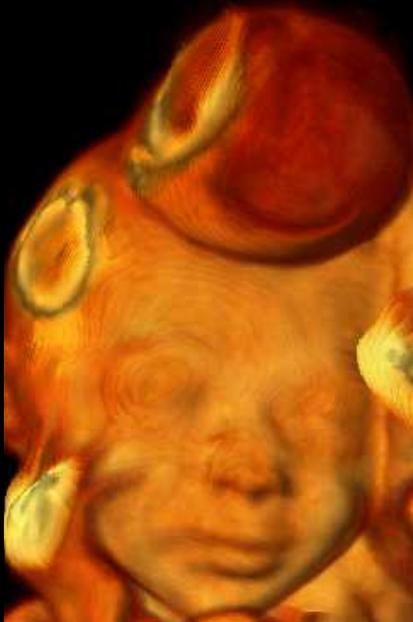
- GOOD FOR RECONSTRUCTIONS
- LONGEST SEQUENCE

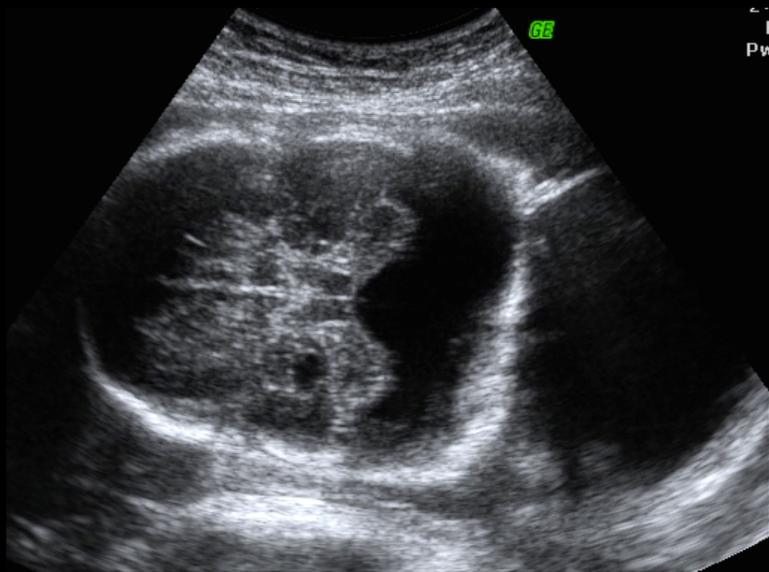
Patient Applications Transfer Edit View Settings Orientation Type Image Tools System Options Help



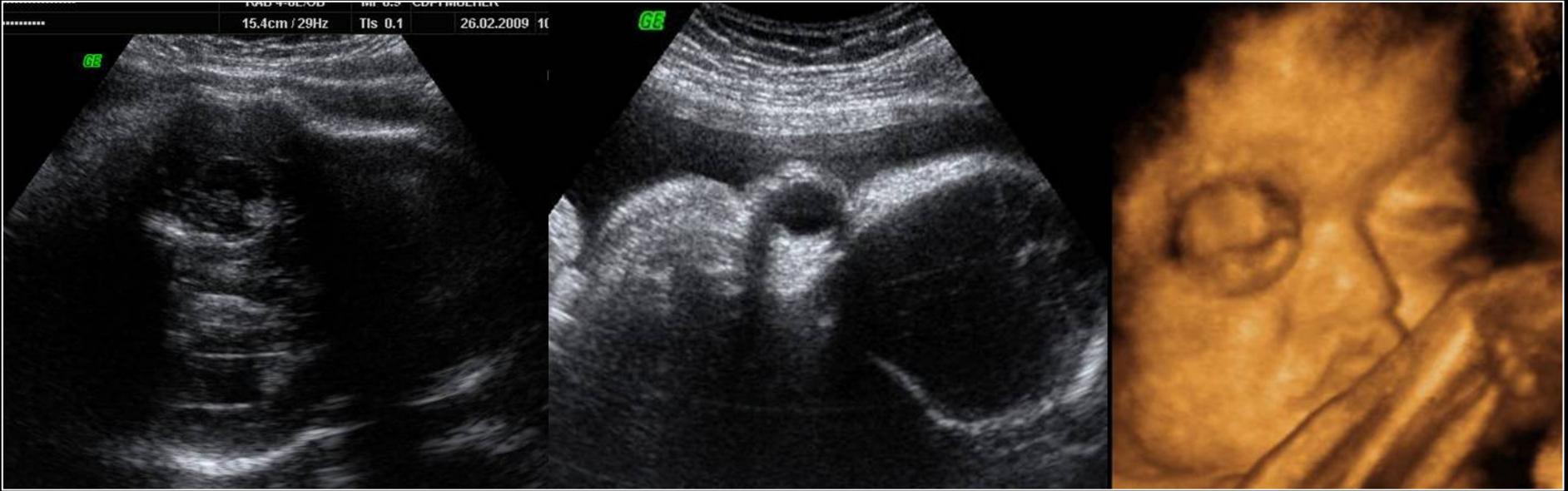
ENCEPHALOCELE

23 weeks



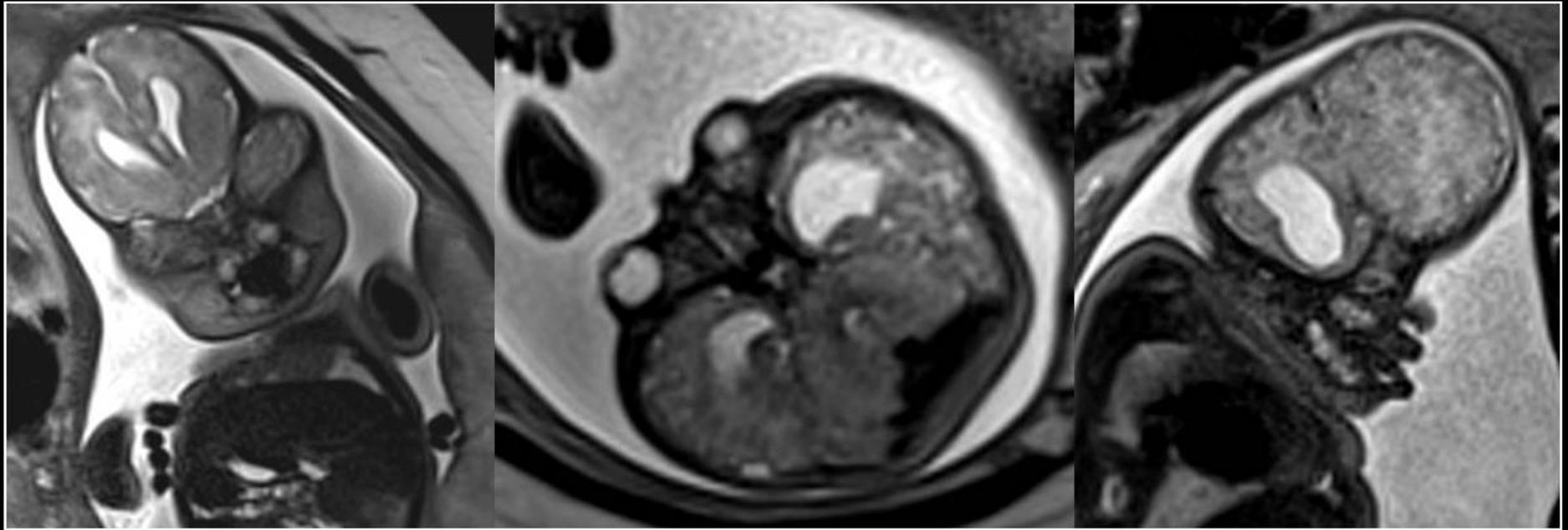


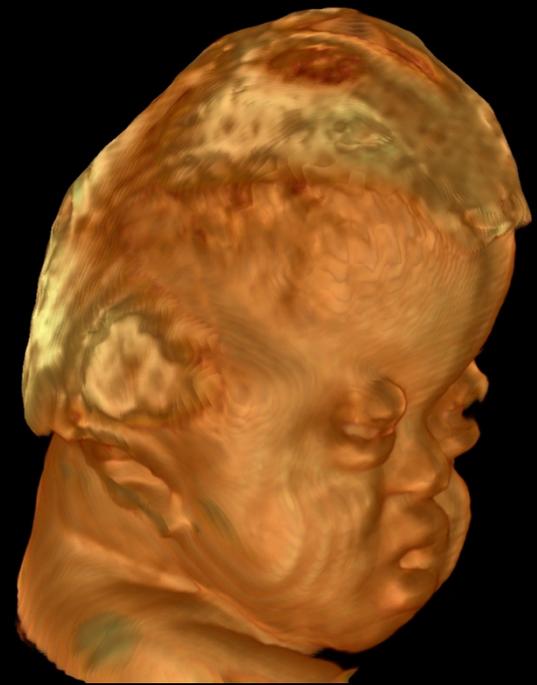
15.4cm / 29Hz TIs 0.1 26.02.2009 10



CRANIOSYNOSTOSIS

36 weeks







A



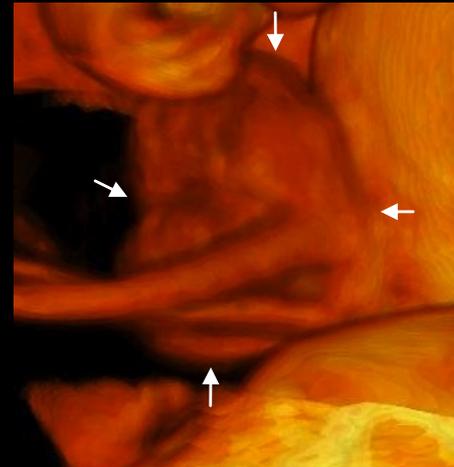
B



C



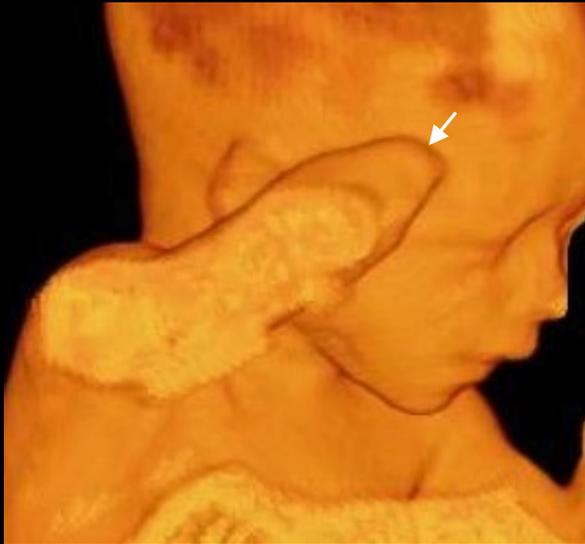
D



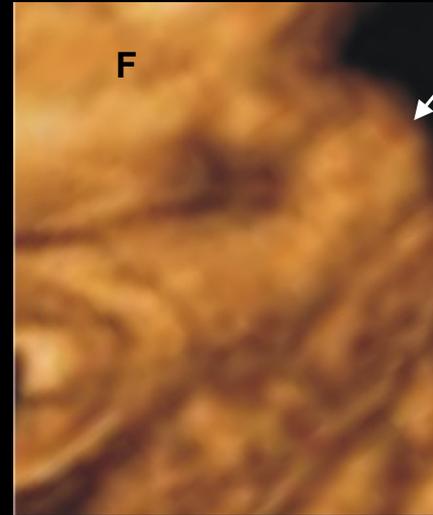
E

BECKWITH WIEDEMANN SYNDROME

26 weeks



A



B

RIGHT FOREARM AMPUTATION



C

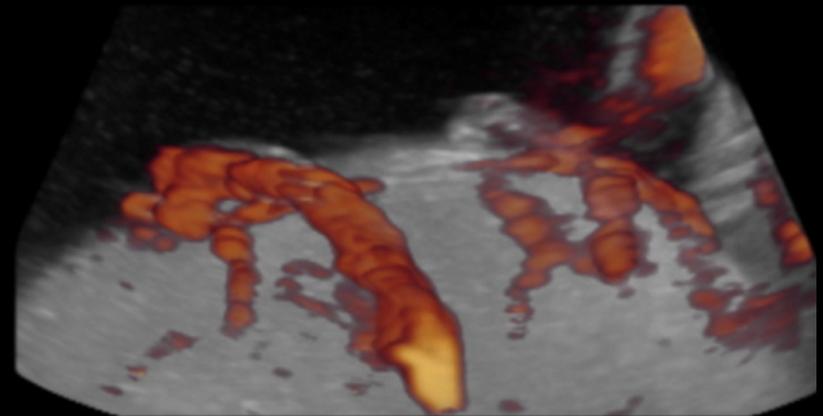


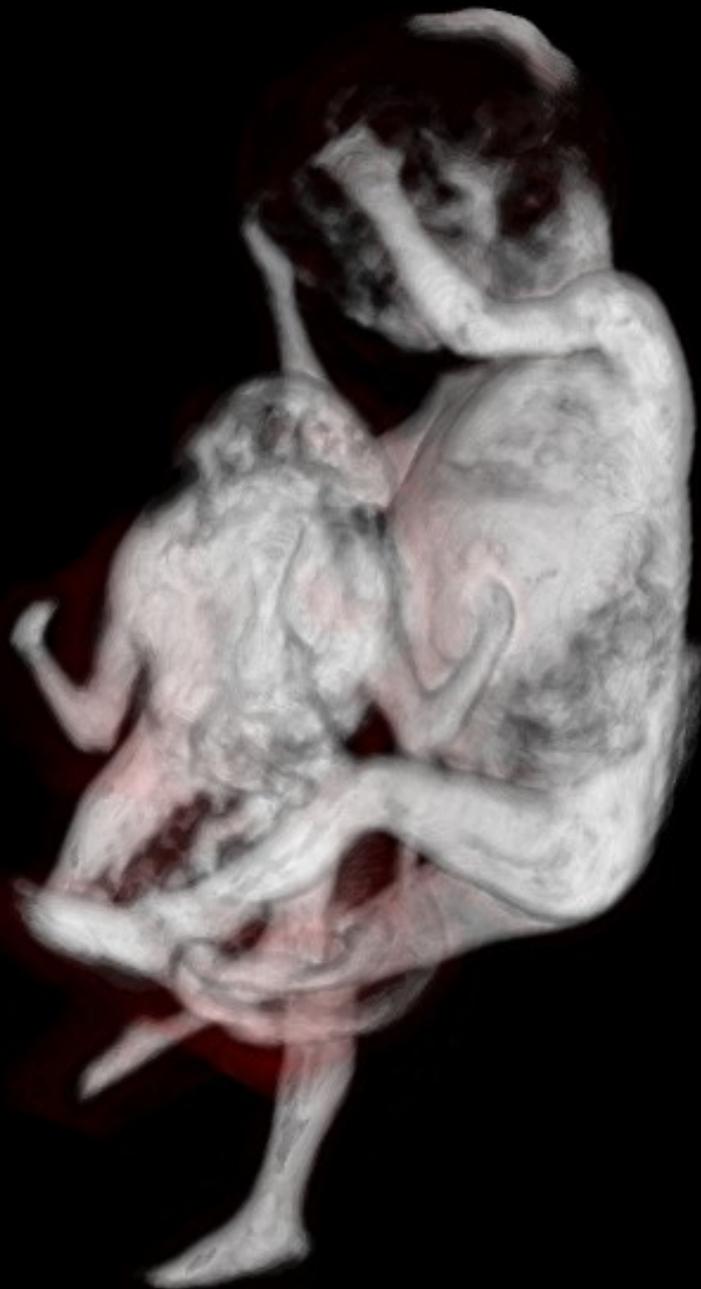
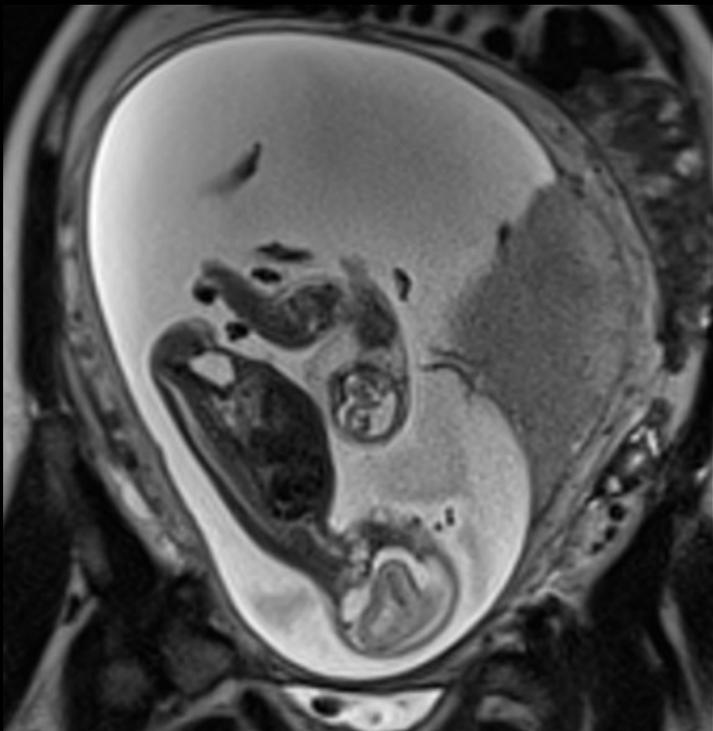
D

TWIN REVERSED ARTERIAL PERFUSION SYNDROME – TRAP

GA=20w1d

10.4cm / 1.3 / 51Hz Tib 0.1



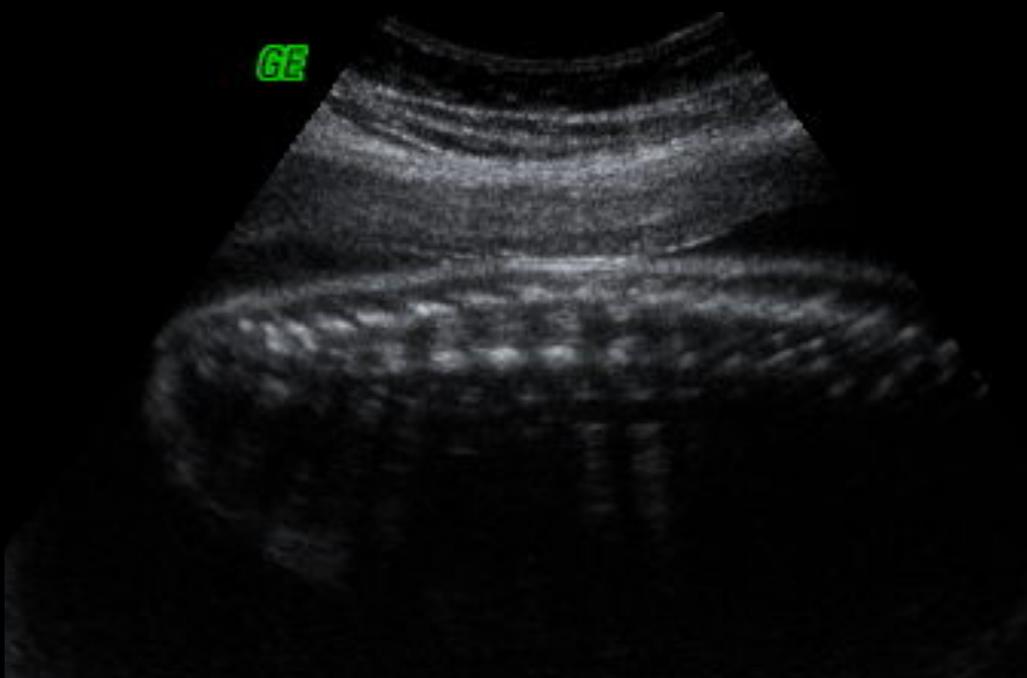
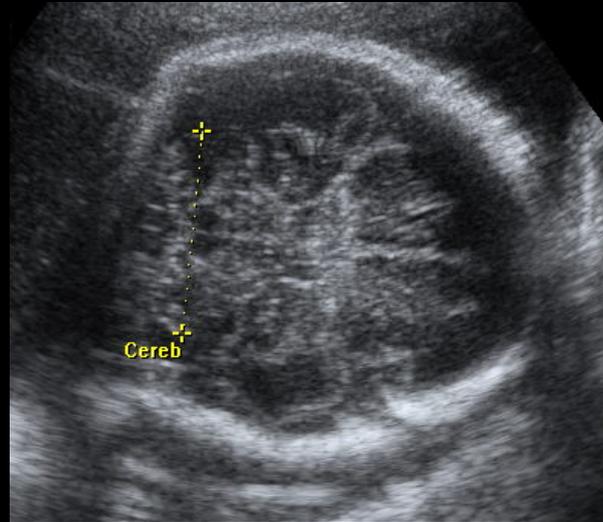


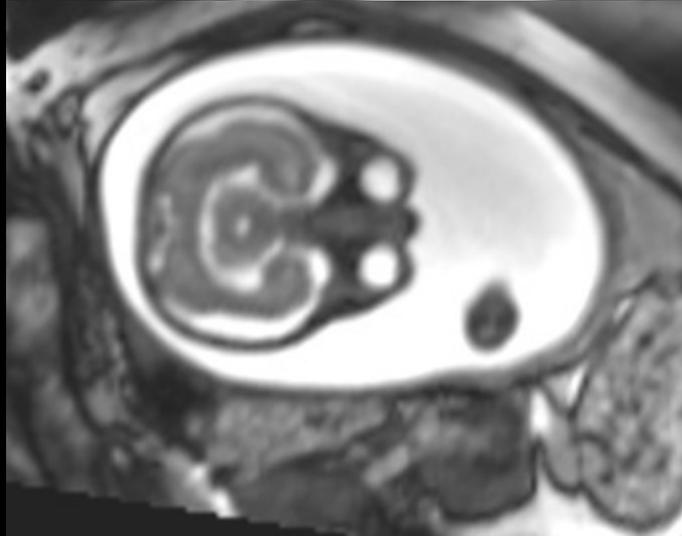
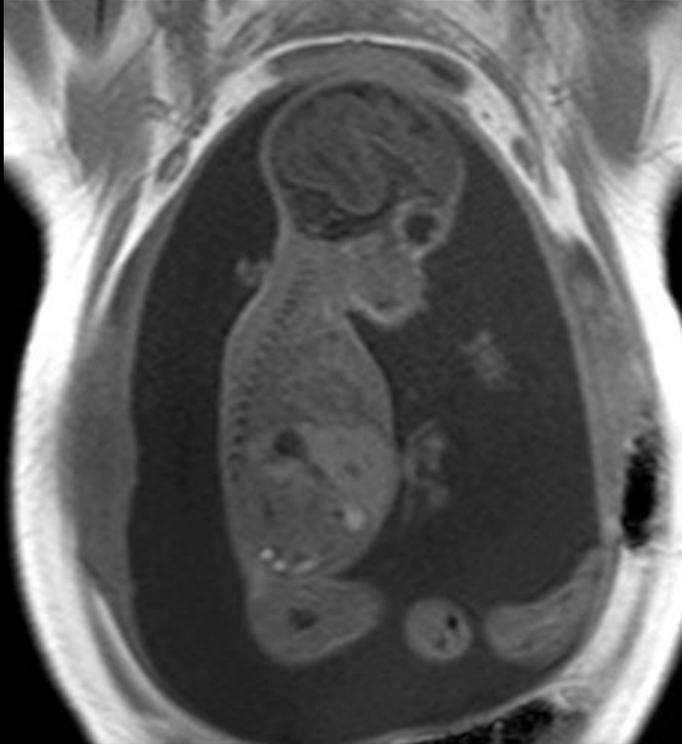
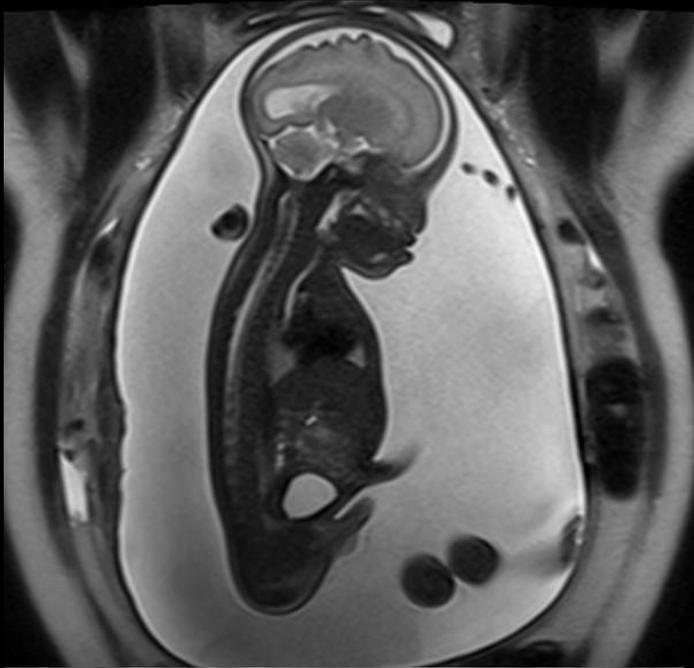
GI - P0

30 years old

USG: 31 weeks

- Brachycephaly
- Hypotelorism
- Hydramnios







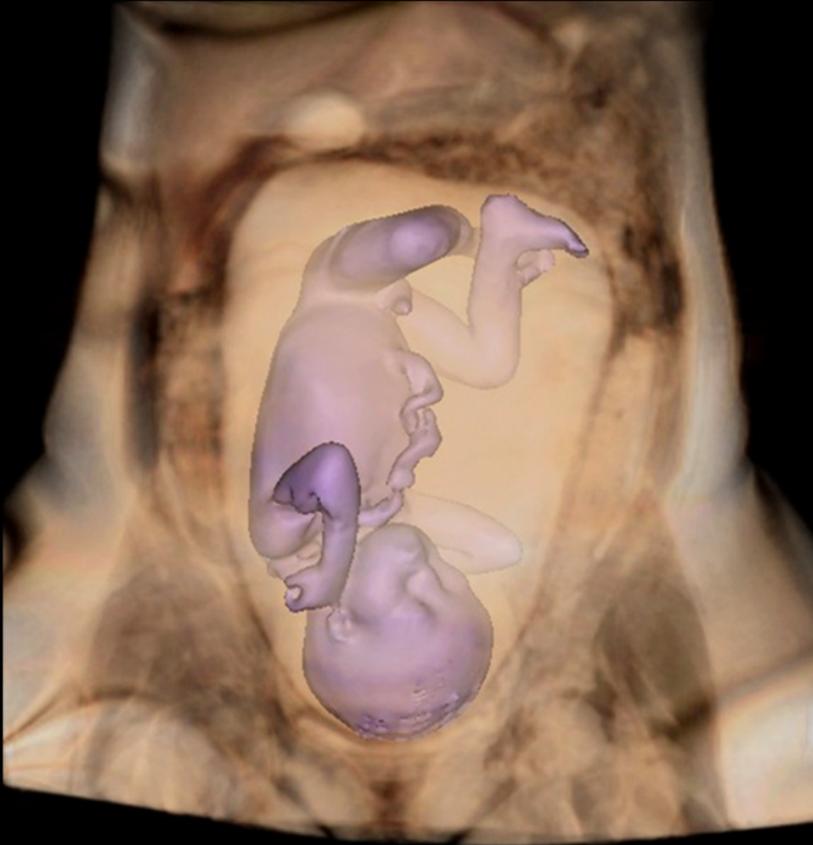
A



B



C

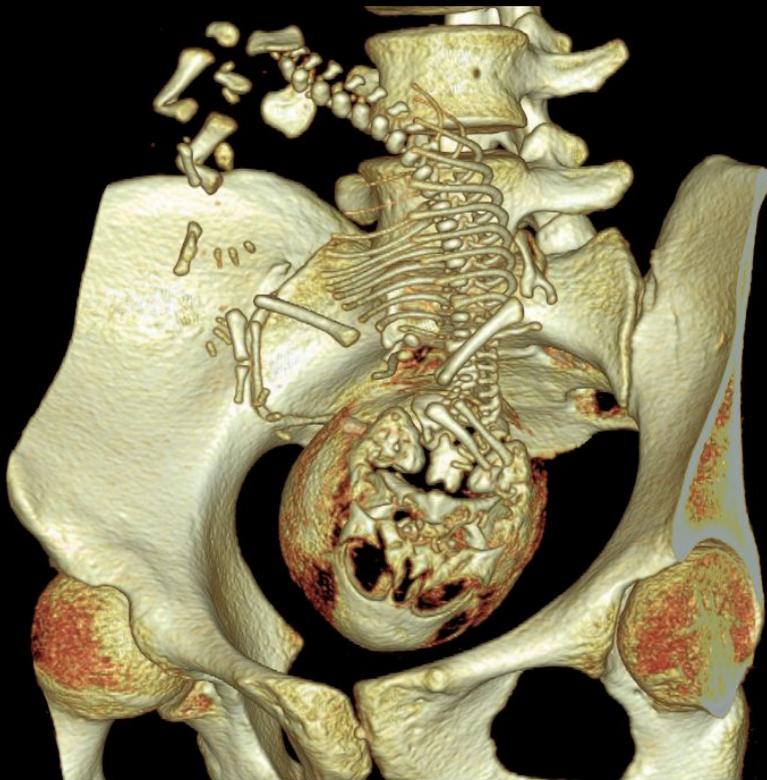


VESTIGIAL TAIL

COMPUTED TOMOGRAPHY

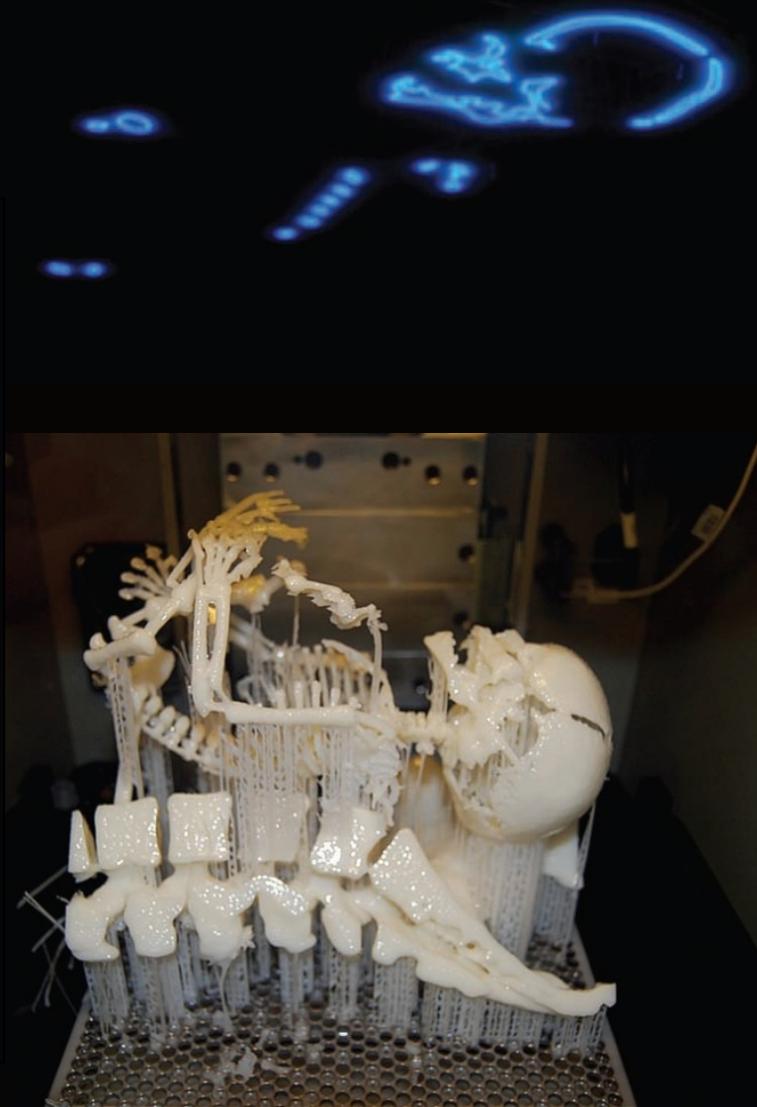
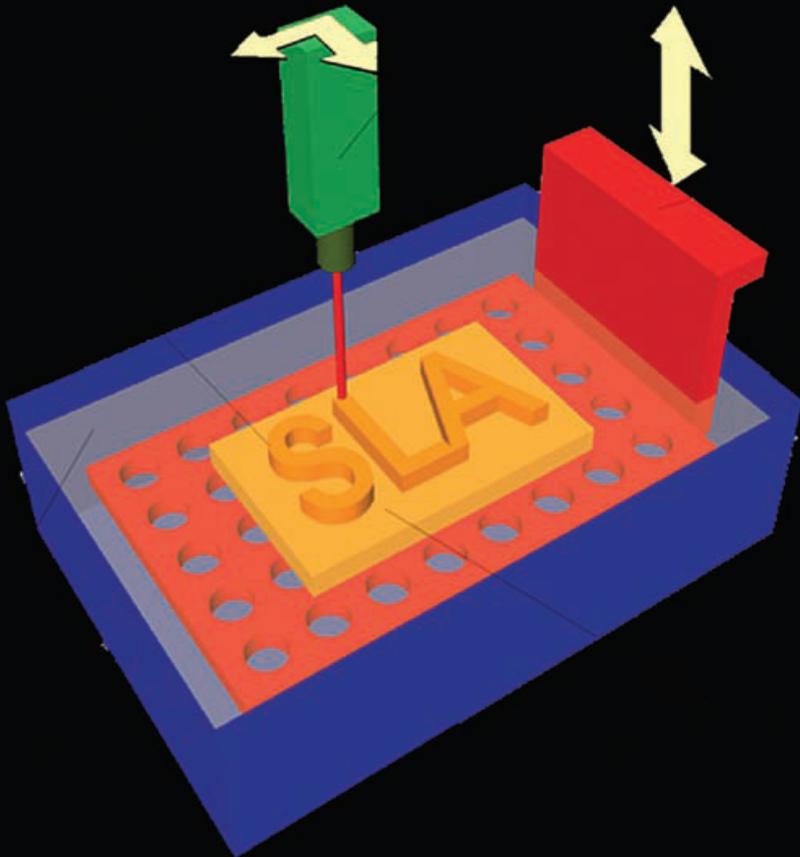
Multislice 64 scanner.

Protocol: 40mAs; 120KV; 64 slices per rotation; 0,75 pitch; 0,75mm slice thickness. CT dose index weighted: 3.12 mGy. *acquisition time: 20s.*



SLA

Stereolithography process.
Liquid-based system.



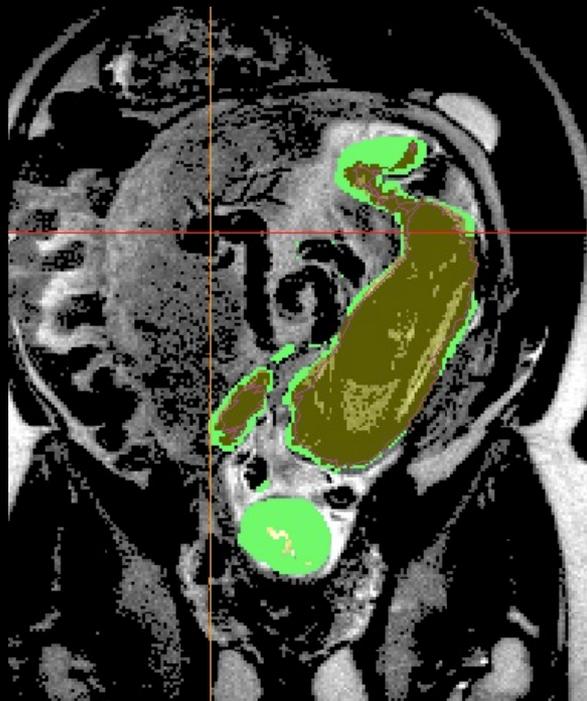


COMPUTED TOMOGRAPHY

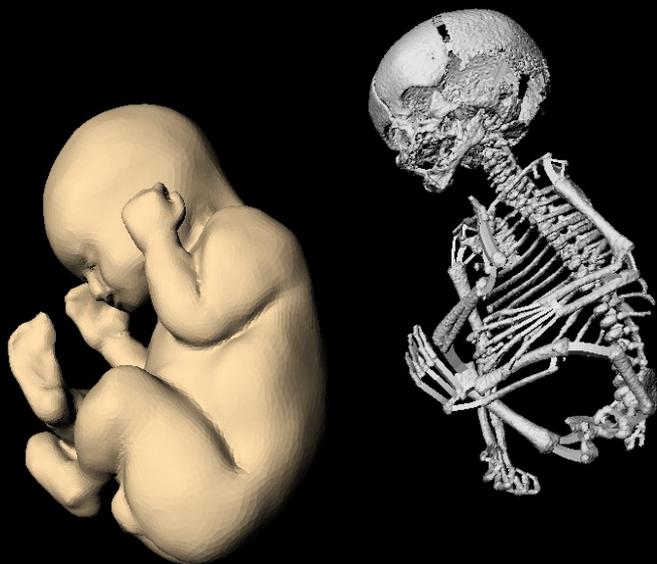
**HYPOPLASTIC LEFT
FEMUR AND TIBIA / LEFT
FIBULAR AGENESIS**



34 weeks



MAGNETIC RESONANCE IMAGING



Letters to the Editor

The use of rapid prototyping didactic models in the study of fetal malformations

The importance of rapid prototyping (RP) in the biomedical sector has been increasing steadily during the past decade. Different uses of RP models have been reported widely in the medical scientific literature¹⁻⁴. In our eight studied cases, of which the final models of two are presented, RP was performed after magnetic resonance imaging (MRI) (Figure 1) or computed tomography (CT) (Figure 2) of fetuses at gestational ages greater than 26 weeks. The indications for MRI were central nervous system, thoracic, gastrointestinal or genitourinary malformations, and skeletal malformations for CT. All cases were examined first by ultrasound imaging. MRI examinations were performed using a 1.5-T scanner (Siemens, Erlangen, Germany). The protocol consisted of T2-weighted sequences in the three planes of the fetal body (HASTE; repetition time, shortest echo time, 140 ms; field of view, 300–200 mm; 256 × 256 matrix; slice thickness, 4 mm; acquisition time, 17–40 slices). The entire examination time did not exceed 30 min⁵. CT was performed using a multislit 64 scanner (Philips, Solingen, Germany) with the following parameters: 40 mA, 120 kV, 64 slices per rotation, pitch 0.75 and slice thickness 0.75 mm. This corresponds to a mean radiation dose to the fetus of 3.12 mSv (CT dose index weighted). The acquisition lasted around 20 s and was performed during maternal apnea⁶.

In order to construct physical models from the medical examinations (MRI and CT) of the cases described, with the aim of didactic use, the first step was the production of three-dimensional (3D) virtual models. These models are made by the use of medical segmentation software (ScanIP version 2.0, Simpleware Ltd., Exeter, UK) to select the contours, allied to design and engineering software (Dassault Systèmes, SolidWorks Corp. and Autodesk Maya) that is used when connections are necessary between parts, and also for surface smoothing and adjustments. When the 3D virtual model is ready, the next step is its physical materialization using RP technology, which works by the principle of overlapping of layers of material (selected according to the RP technology)⁷.

In the first case, to build the model presented (Figure 1), the technology adopted was fused deposition modeling. The material used was thermoplastic acrylonitrile butadiene styrene and the total machine time for the RP construction was 32 h. The model required a supporting water-soluble material, which was removed after the construction process through immersion in an ultrasound bath in a liquid release agent. The final production cost of this model was US\$280.



Figure 1 Rapid prototyping model of a fetus created using fused deposition modeling after magnetic resonance imaging at 34 weeks.

The second model presented was made using the 3D Systems Viper Stereolithography process (Figure 2), in which a laser is used to 'draw' successive cross-sectional layers in a photoactive resin. The building process was followed by a postprocessing stage, in which the support was removed and the piece cleaned by removing polymer residues that did not harden during the building process. The model was then totally hardened under ultraviolet light. The RP machine time was 26 h, with a final production cost of US\$420.

Through the associated use of MRI and CT with RP technologies, we believe that physical models will help, in a didactic, tactile and interactive manner, the study of complex malformations by a multidisciplinary staff.



Figure 2 Rapid prototyping model of the skeleton of a fetus created using stereolithography after computed tomography at 35 weeks.



Powder-based
System

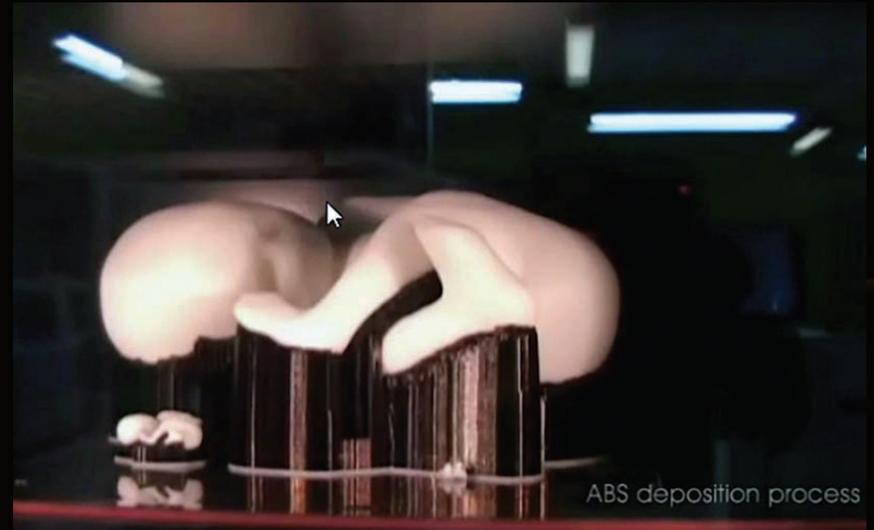


FDM

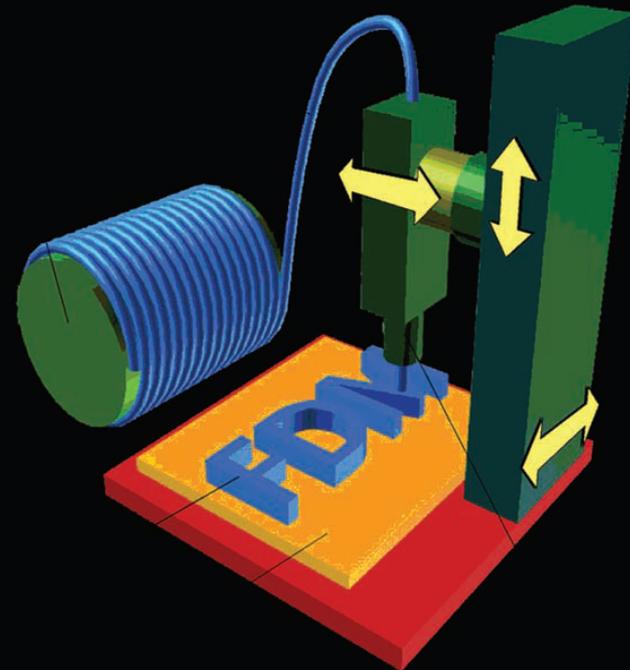
Fused Deposition Modeling



feto 3D



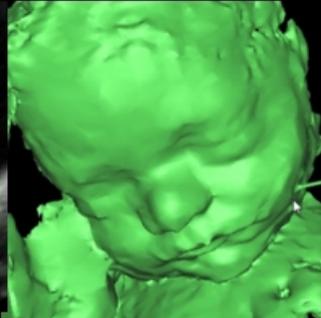
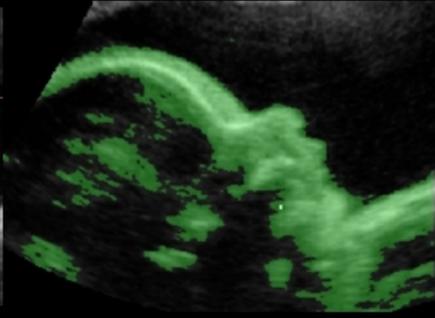
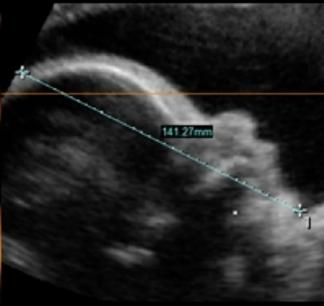
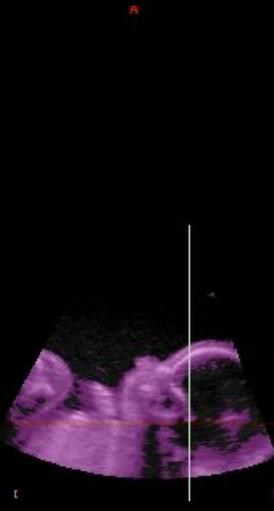
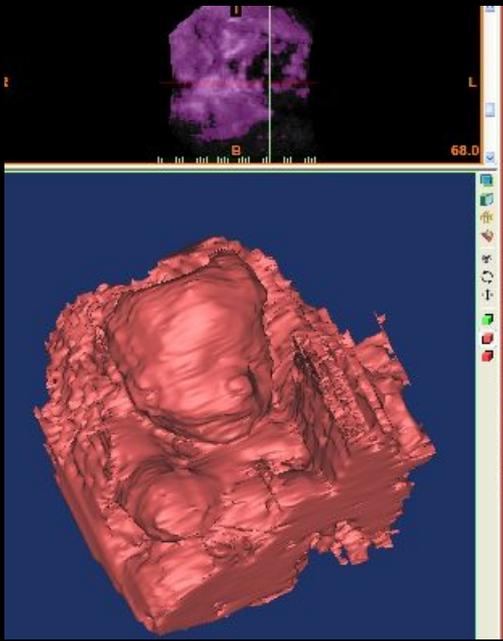
ABS deposition process

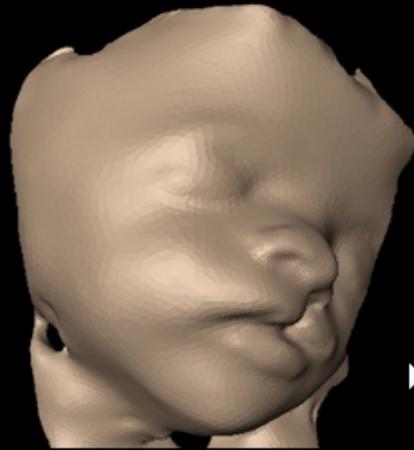




This physical model is the result of an MRI file of a fetus at 34 weeks of gestation, using OBJET technology, which allows an internal fetal vision from a composition of several kinds of materials.

ULTRASONOGRAPHY





ULTRASOUND in Obstetrics & Gynecology

The Official Journal of
the International Society of Ultrasound
in Obstetrics and Gynecology



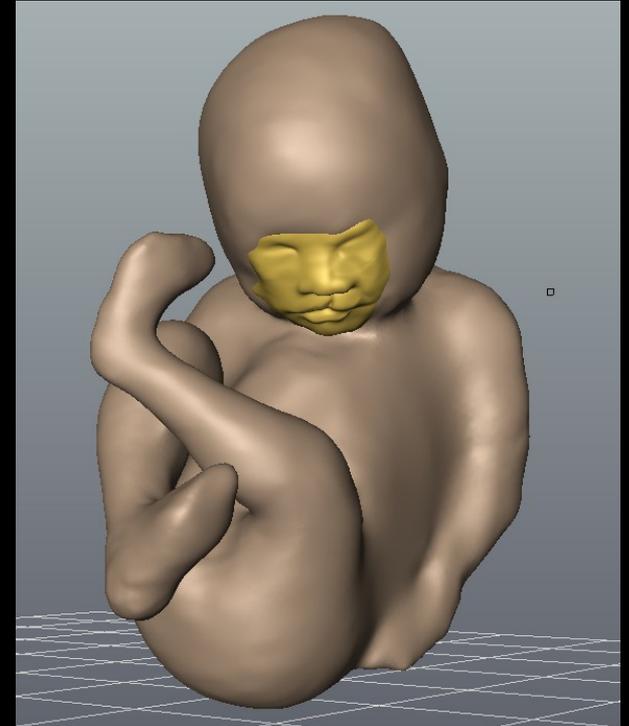
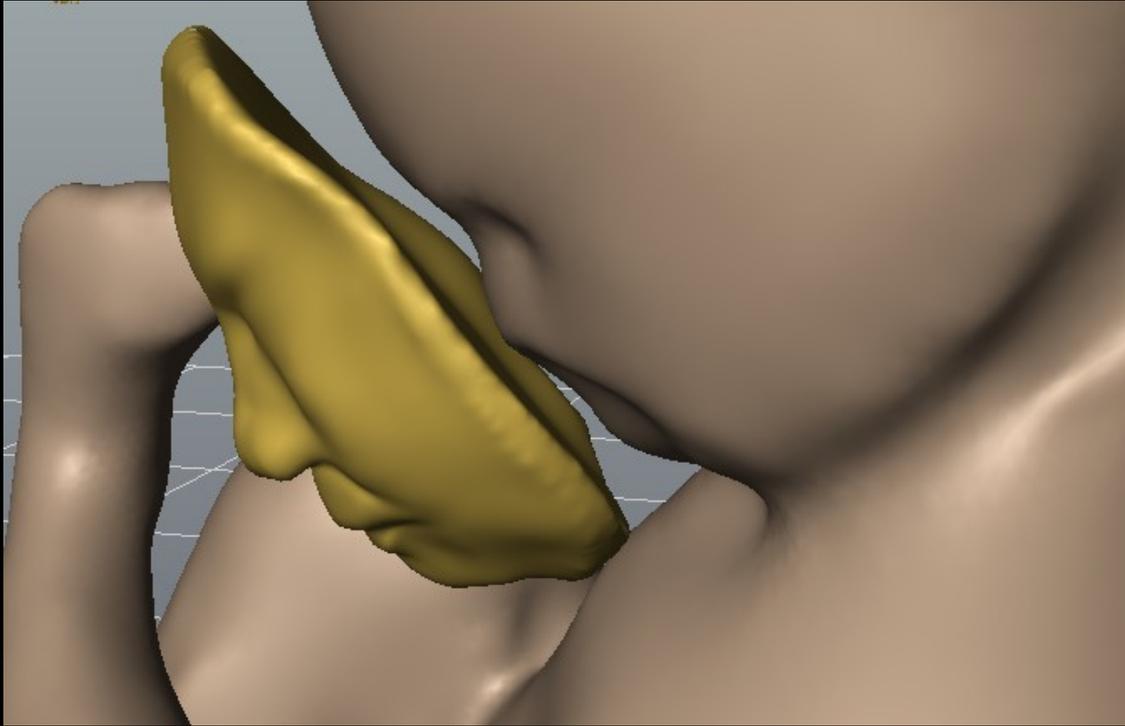
isuog[®]



CLEFT LIP

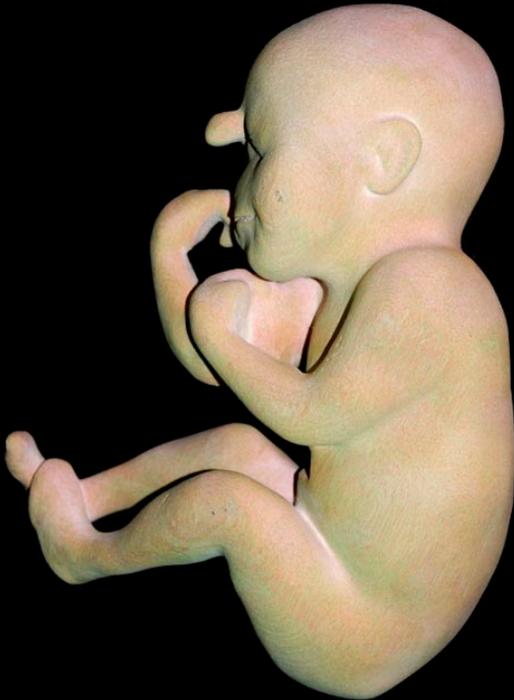
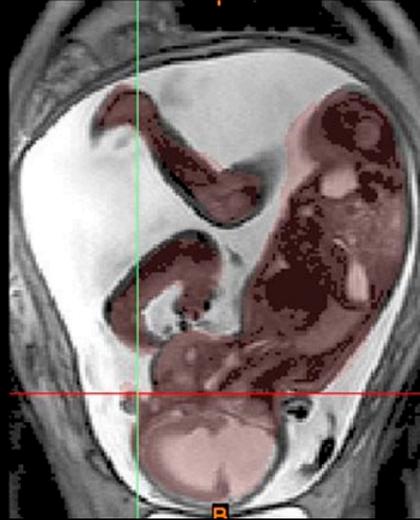
WILEY-
BLACKWELL

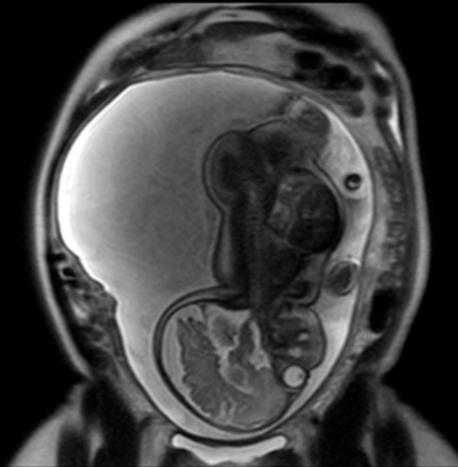
CLEFT LIP



Inserting virtual face generated by ultrasound in 3D body model generated by MRI.

ALOBAR HOLOPROSENCEPHALY



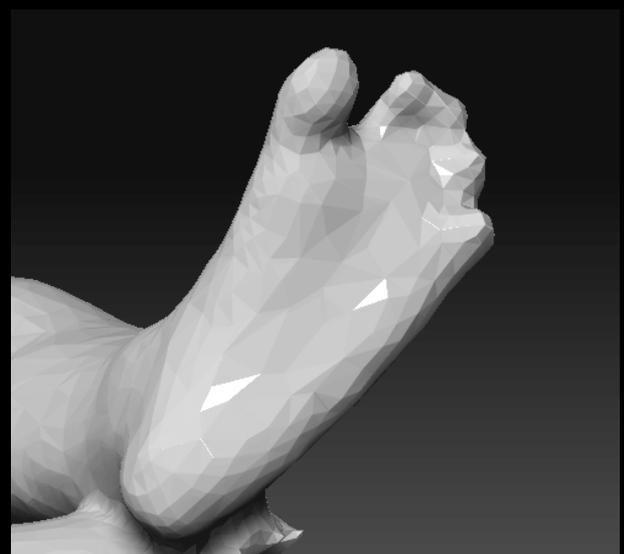


ACONDROGENESIS





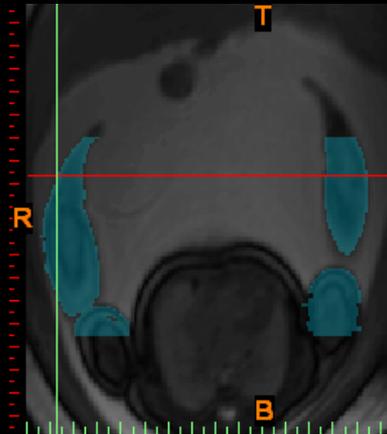
TRISOMY 21



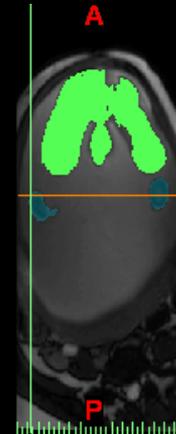


APERT SYNDROME

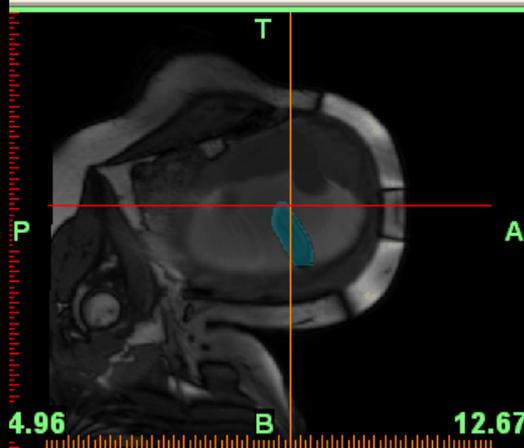
29 weeks



229.69



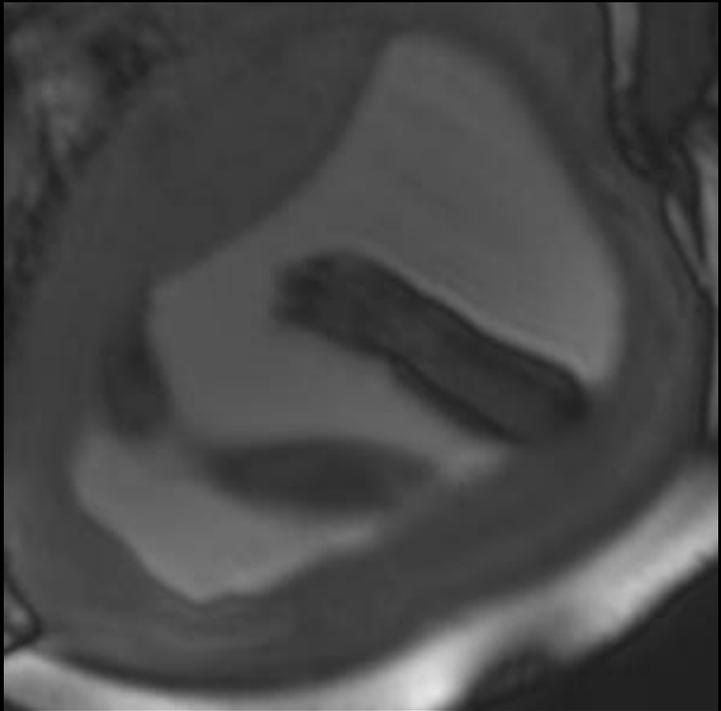
232.!



4.96

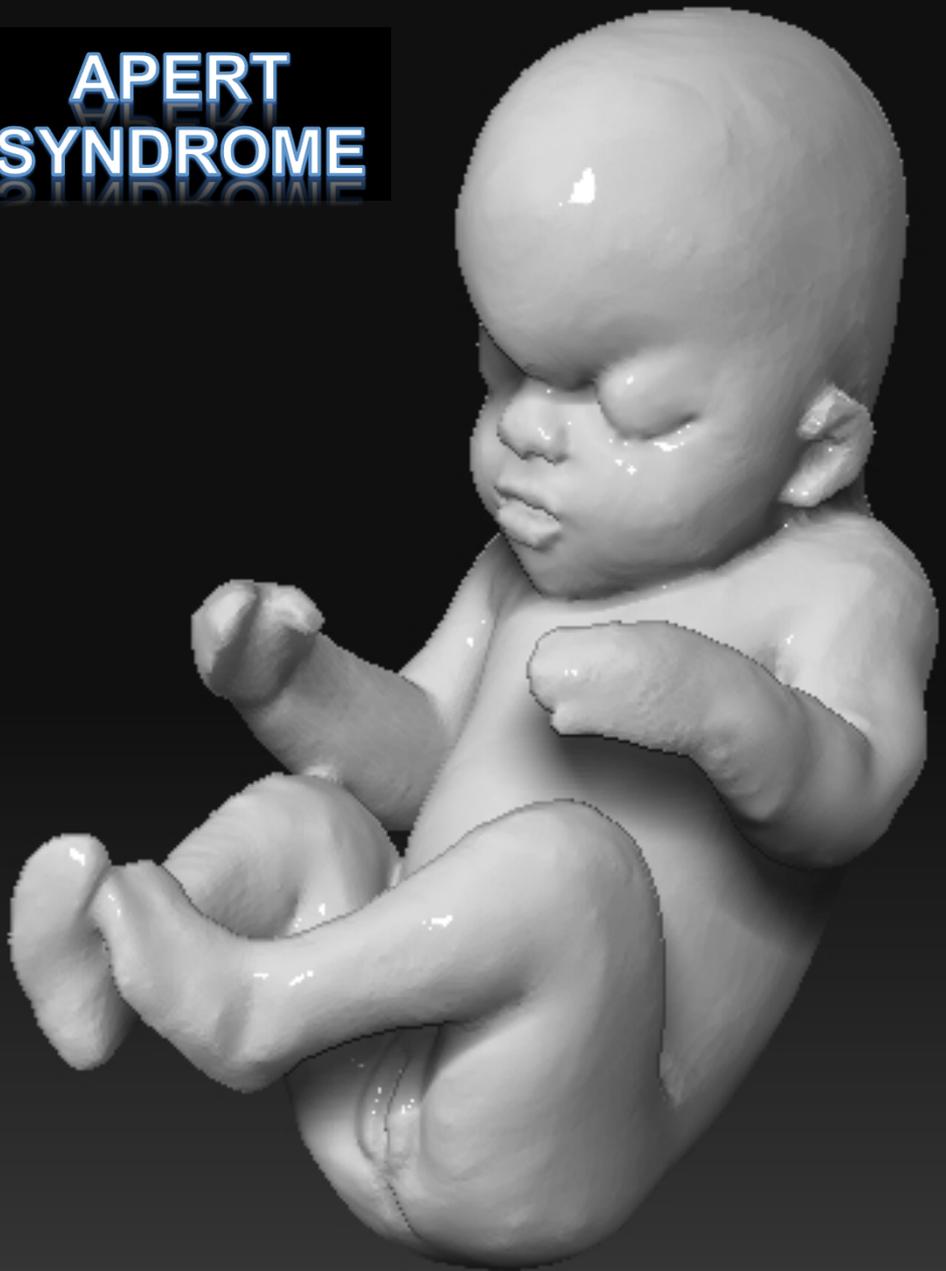
12.67

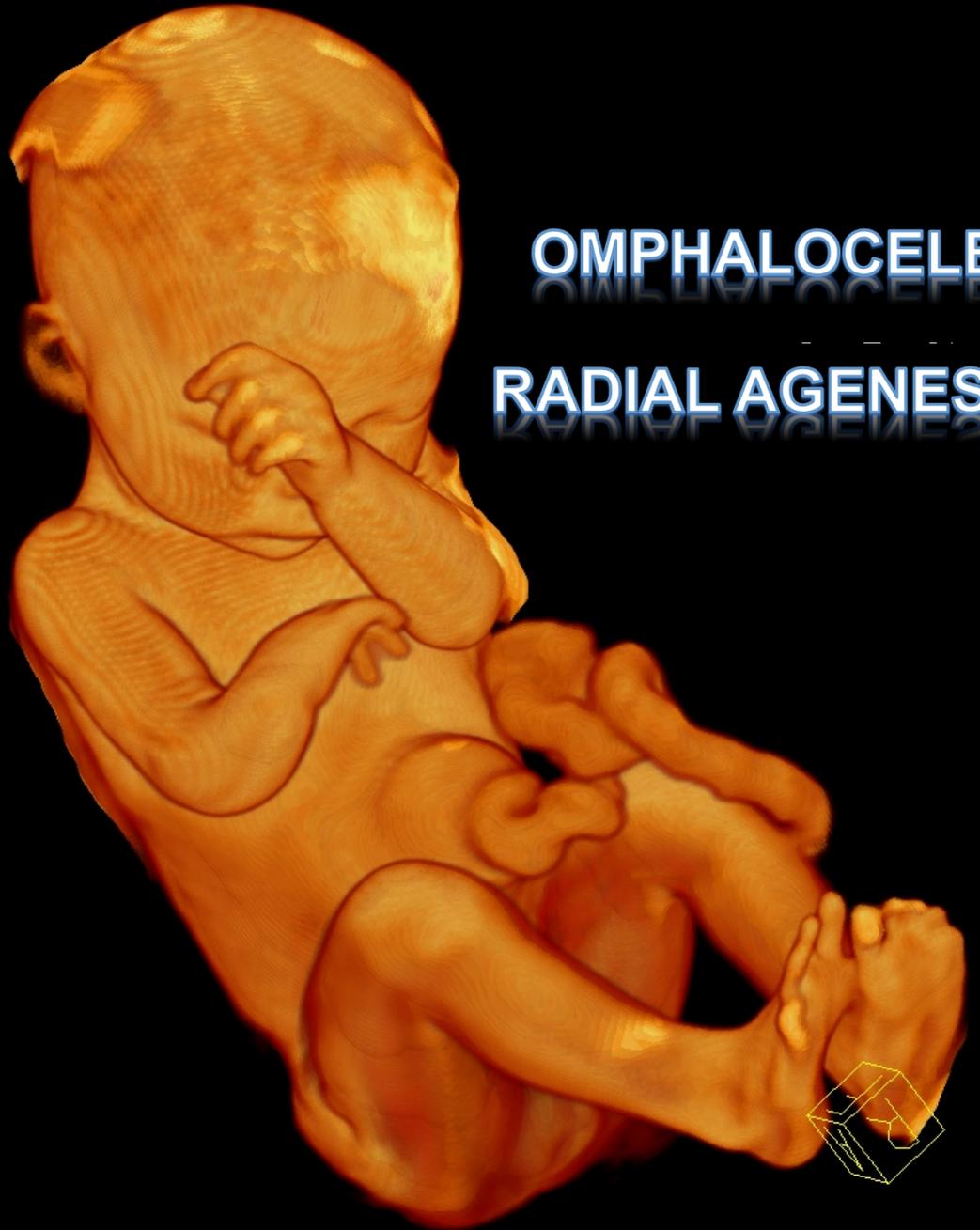




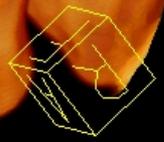


APERT SYNDROME





OMPHALOCELE
RADIAL AGENESIS





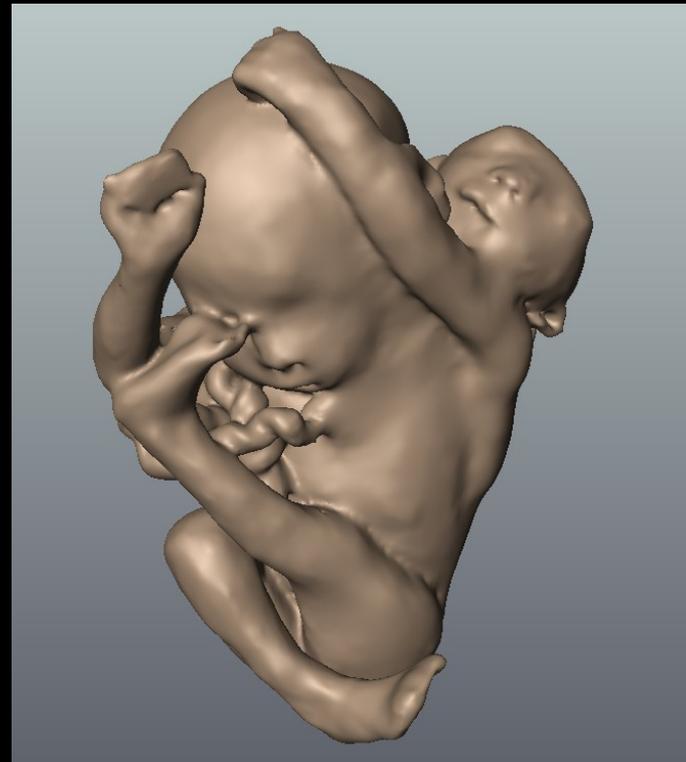
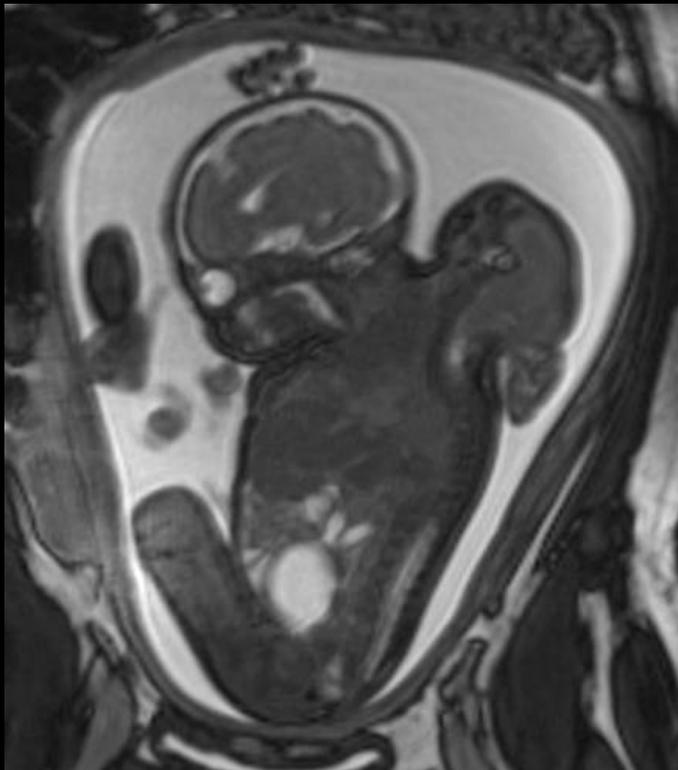


RAB 4-8L/0B MI 1.0 CDPI MULHER
2.4/8.7cm / 1.5Hz TIs 0.2 21.01.2010 09:30:14

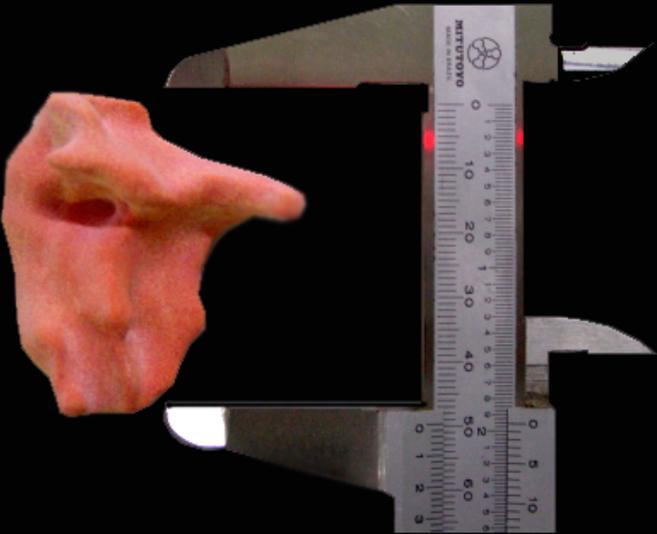
Default
Th56/Qual max
B65°/V65°
Mix40/60
4D Real Time

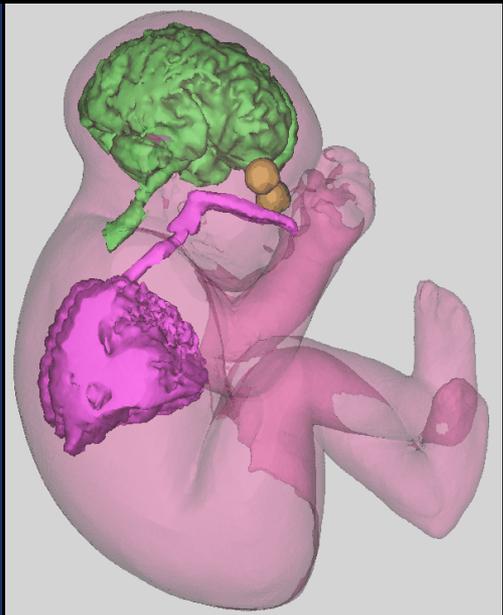
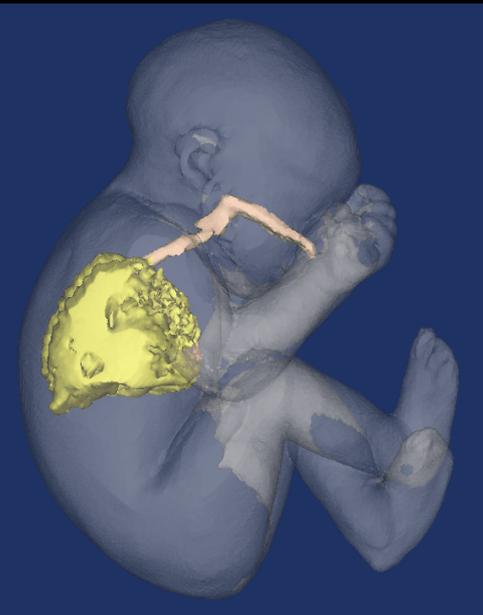
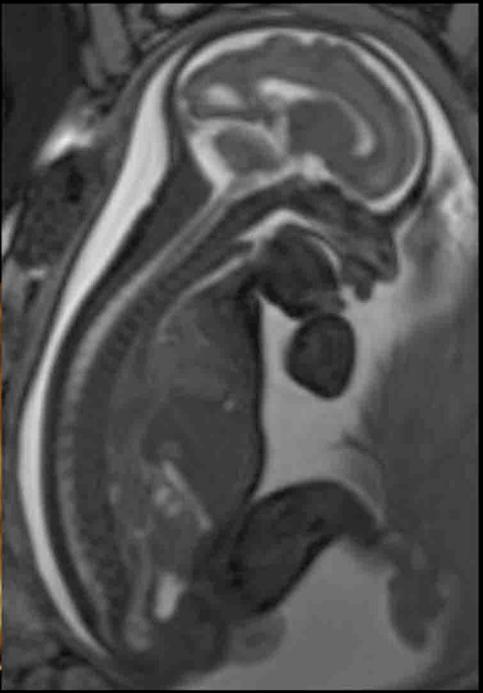
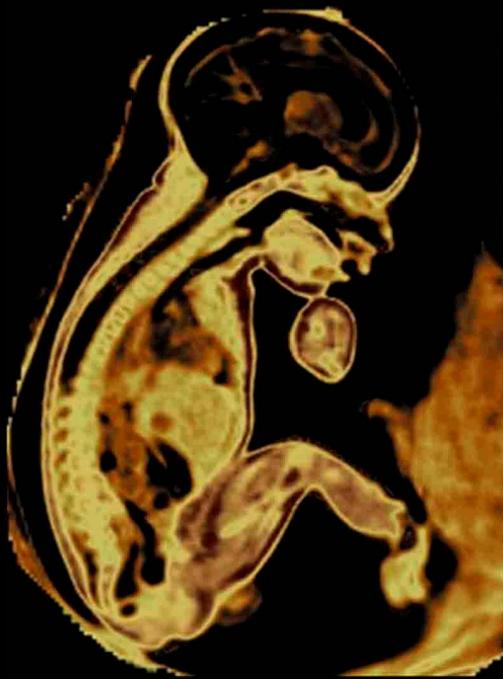


DICEFALOS



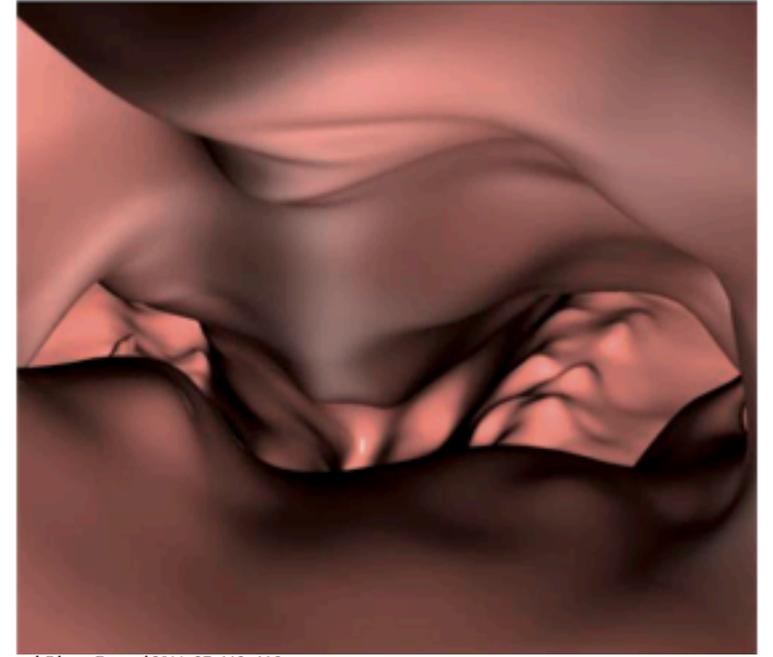
LUNG - DIAPHRAGMATIC HERNIA





ULTRASOUND in Obstetrics & Gynecology

The Official Journal of
the International Society of Ultrasound
in Obstetrics and Gynecology



Ultrasound Obstet Gynecol 2011; 37: 113–115
Published online in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/uog.8886

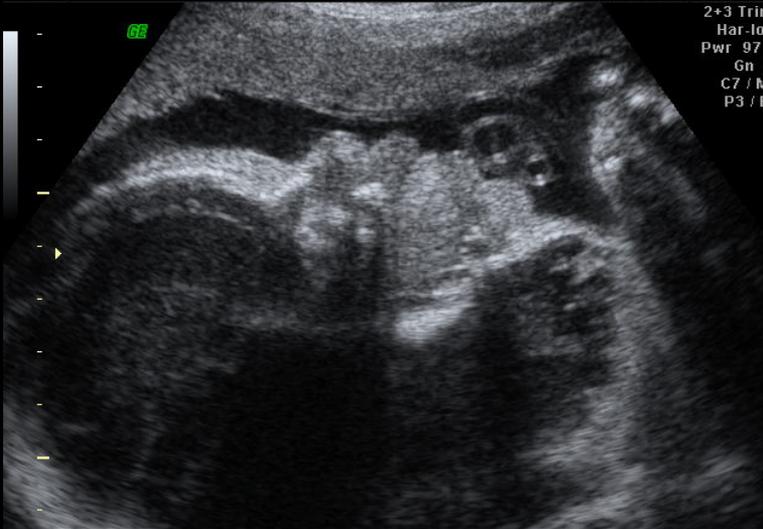
Picture of the Month

Virtual bronchoscopy in the fetus

H. WERNER*†, J. R. L. DOS SANTOS‡, R. FONTES‡, P. DALTRO*†, E. GASPARETTO*†,
E. MARCHIORI† and S. CAMPBELL§



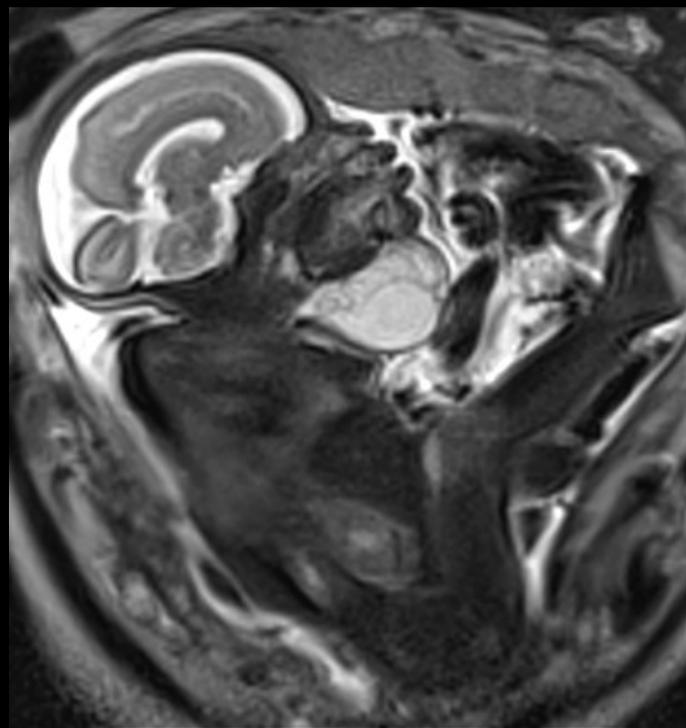
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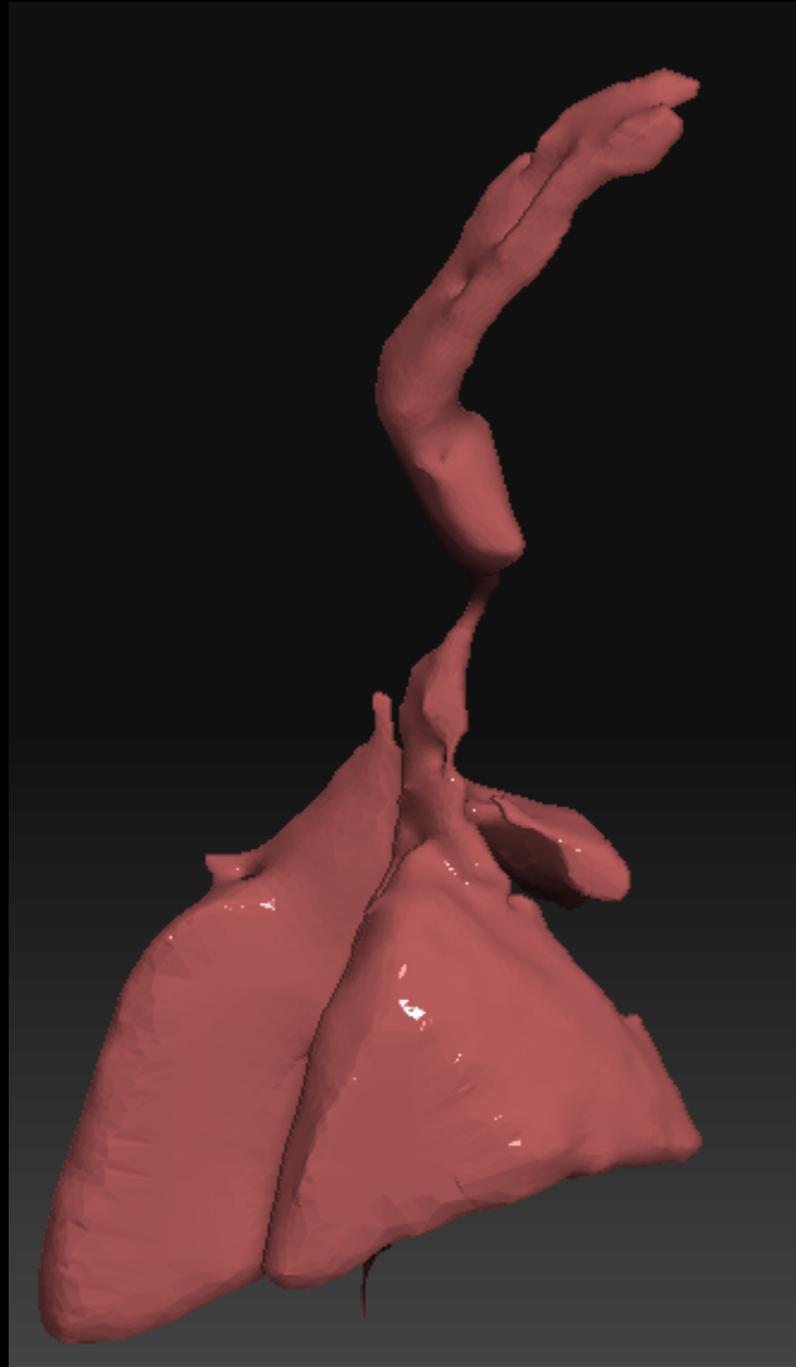
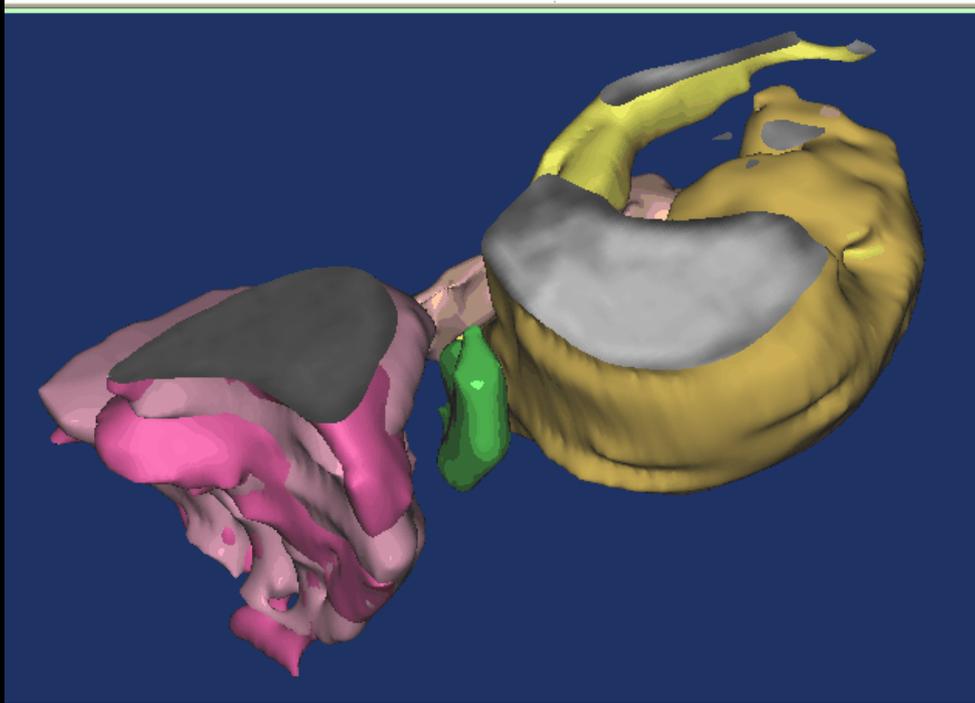
2+3 Trim
 Har-low
 Pwr 97 %
 Gn
 C7 / M
 P3 / E

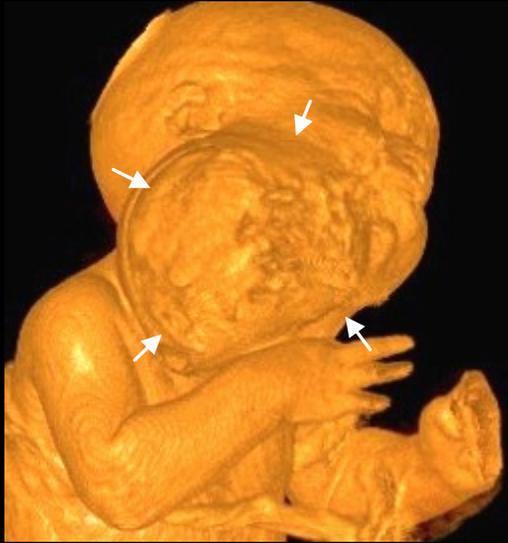


Ref: HERON WERNER

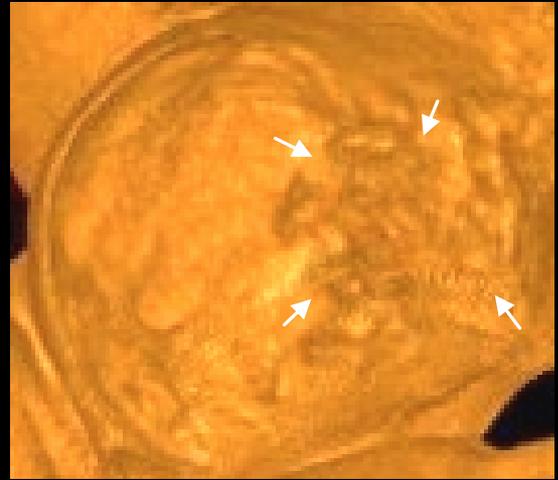


LYMPHANGIOMA





A



B

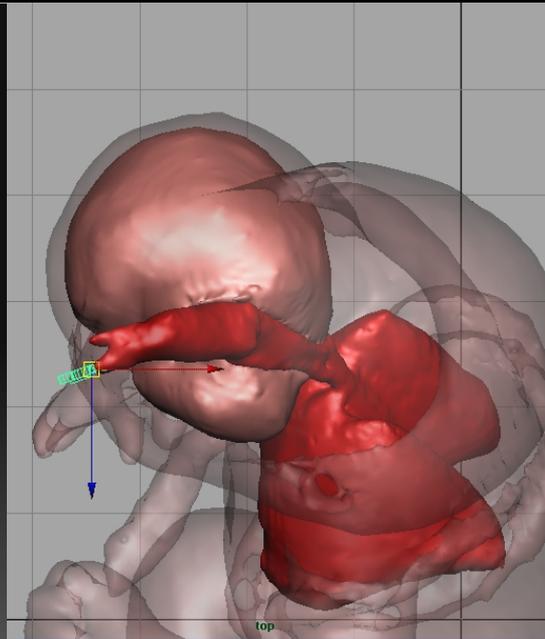
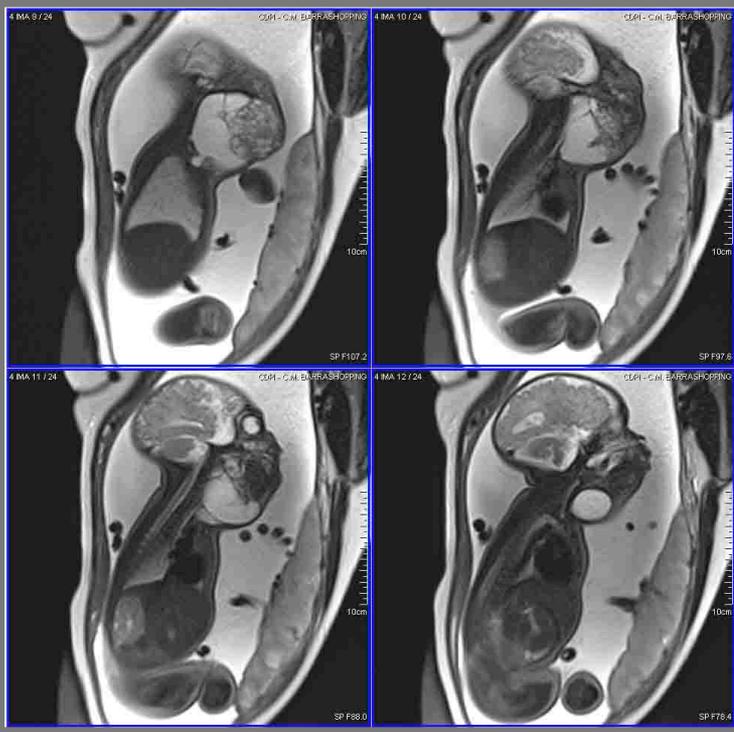
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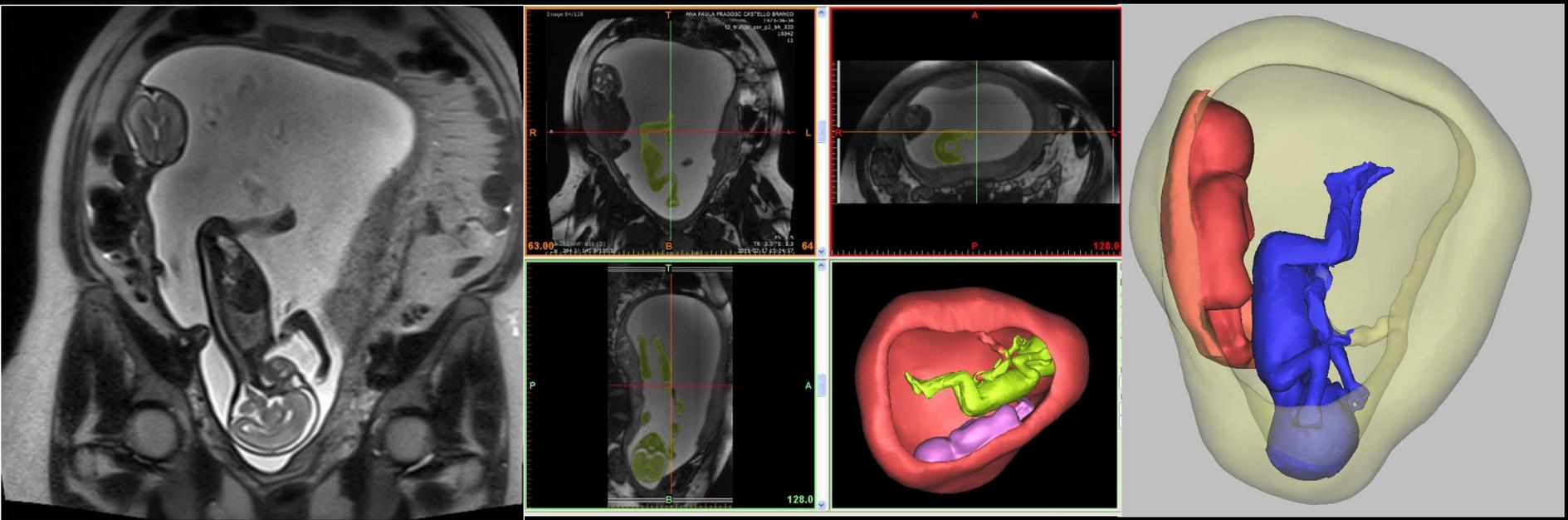


C



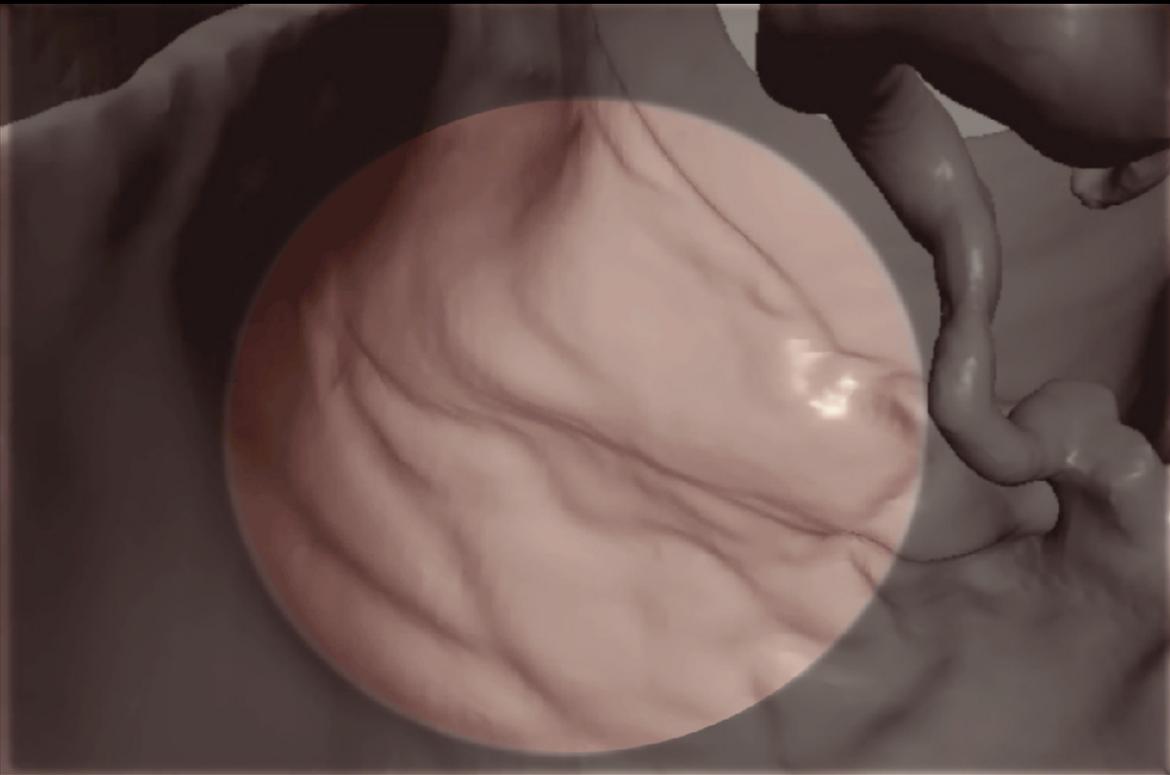
D





TWIN TO TWIN TRANSFUSION SYNDROME





**TWIN TO TWIN TRANSFUSION
SYNDROME**



CONCLUSIONS



- Ultrasound is the first method for screening fetal malformations.
- Ultrasound, MRI and CT are methods which complement the diagnosis and evaluation of fetal prognosis.
- 3D / 4D imaging can help in fetal evaluation.

THANK YOU!



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