

10° Corso A.O.G.O.I.  
9° Turin IAN DONALD Course

TEST DI SCREENING  
E DI DIAGNOSI PRENATALE  
FRA PASSATO E FUTURO

*PRENATAL SCREENING  
AND DIAGNOSTIC TESTS BETWEEN  
THE PAST AND THE FUTURE*

Torino, 15-16 marzo 2024  
Hotel NH S. Stefano



DIRETTORE DEL CORSO  
Elsa Viora - Torino

# Neurosonologia Fetale

## Vincenzo D'Addario Bari

# Obiettivi

- Una nota storica
- La situazione attuale della neurosonologia fetale
  - Lo screening
  - L'esame di riferimento
  - Esempi di passaggio dal segno sospetto dello screening alla diagnosi dell'esame di riferimento
- Le prospettive future

# Dubrovnik 1983



J. Perinat. Med.  
13 (1985) 67

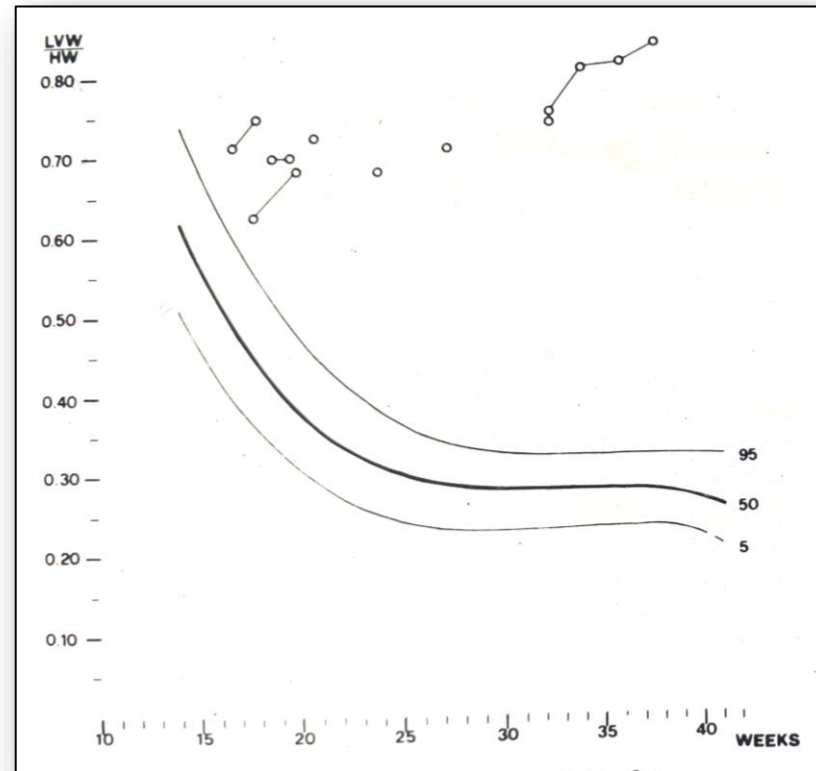
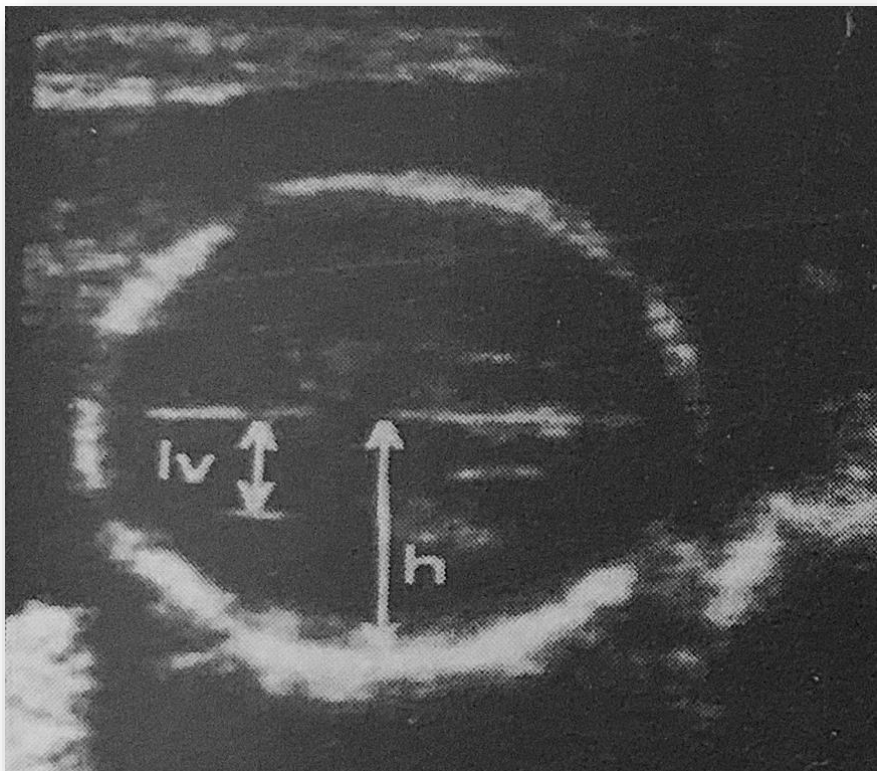


## Ultrasound investigation of the fetal cerebral ventricles

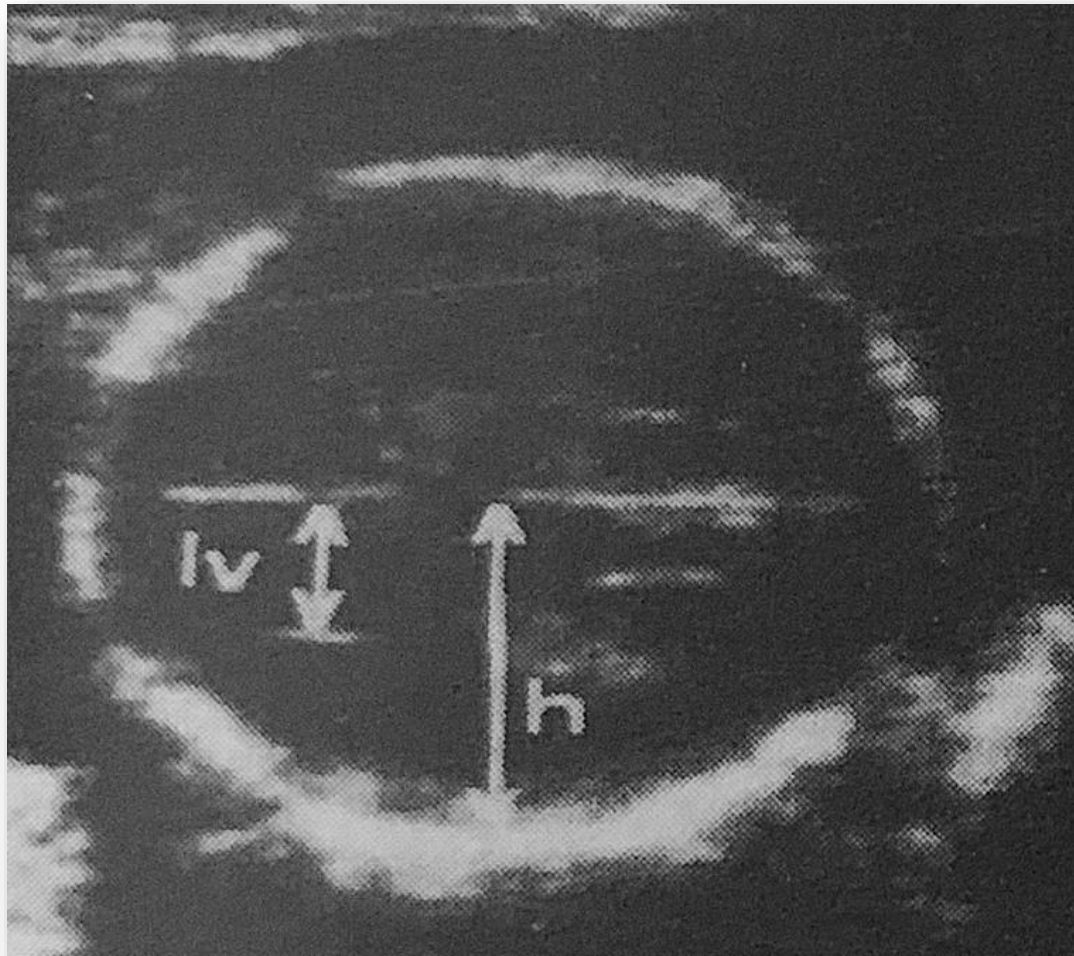
V. D'Addario, A. Kurjak\*

1st Department of Obstetrics and Gynecology, University of Bari, Italy

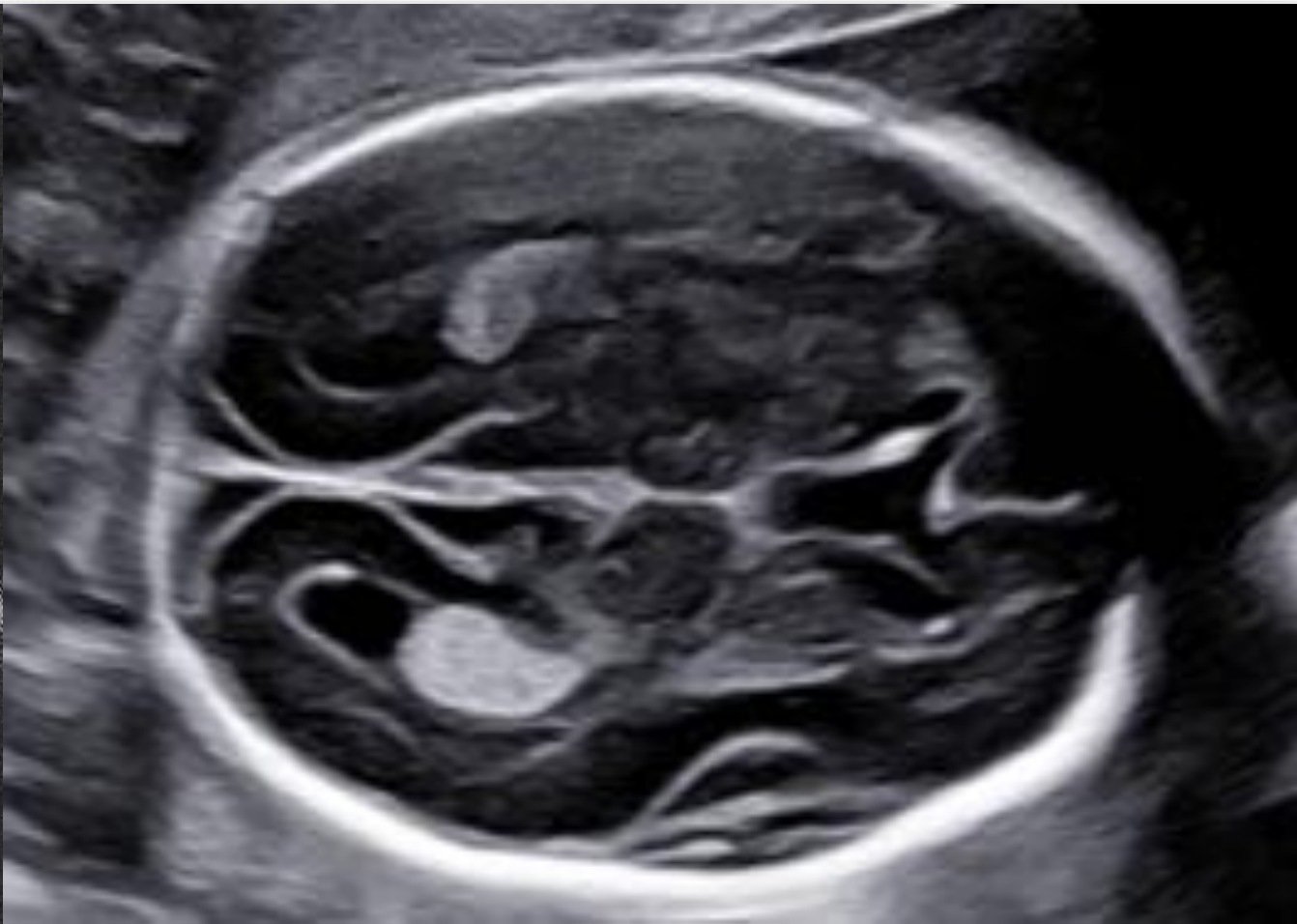
\* Ultrasonics Institute Dr. J. Kajfeš Hospital, Zagreb, Yugoslavia



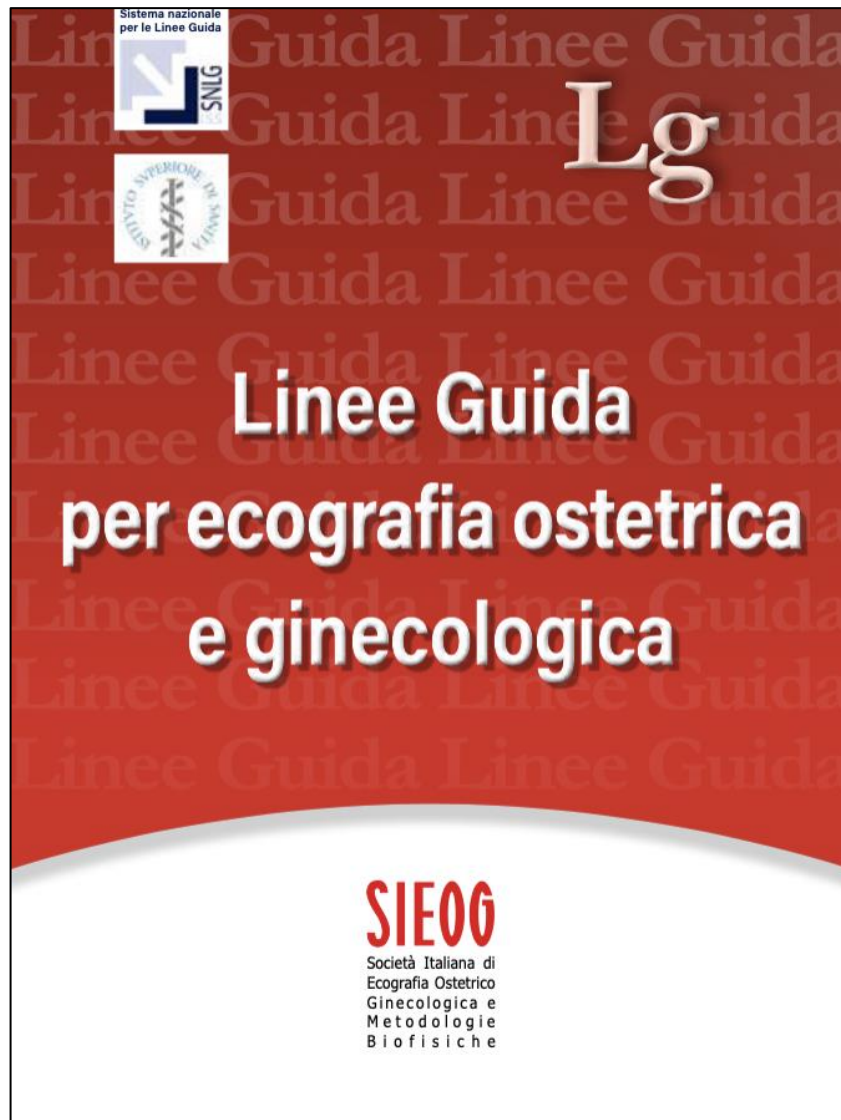




1984

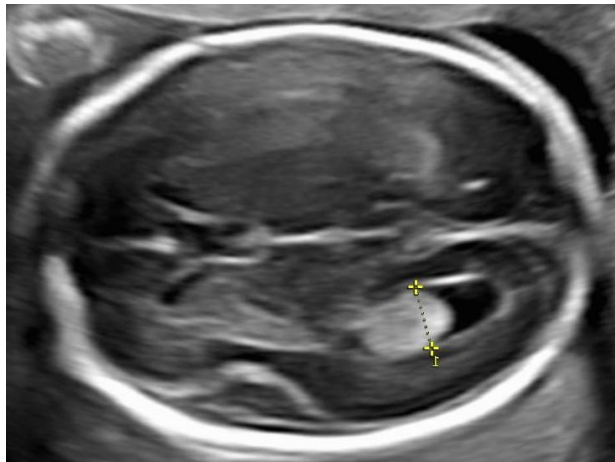
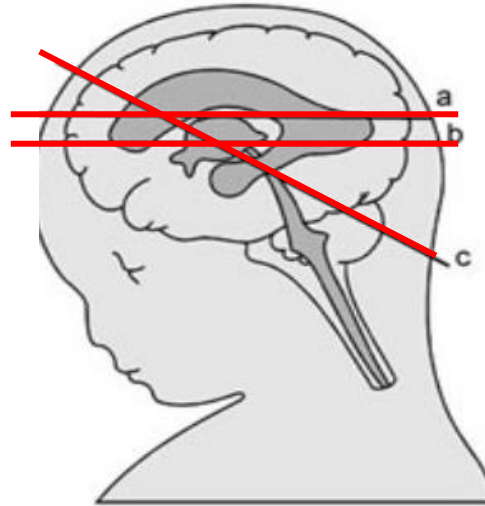


2024

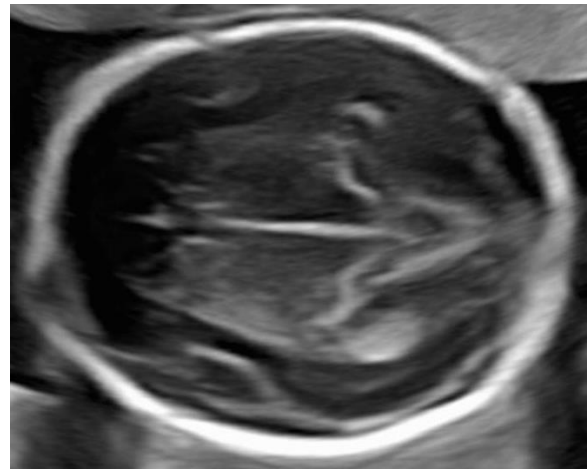


**2021**

# Esame di screening: 3 scansioni assiali



Transventricolare



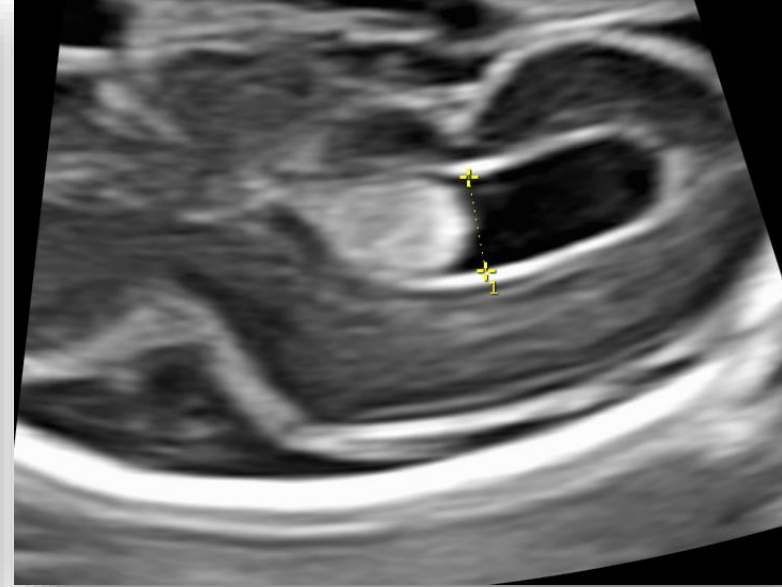
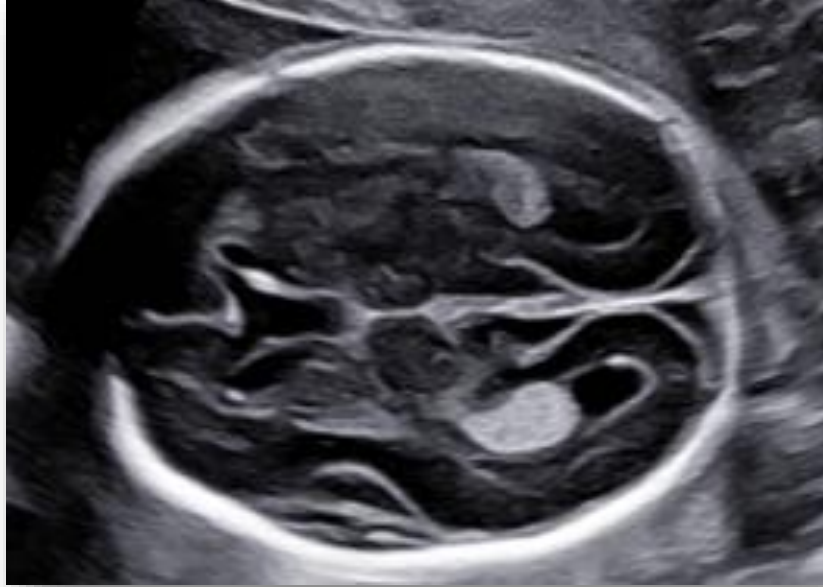
Transtalamica



Transcerebellare



# Scansione transventricolare

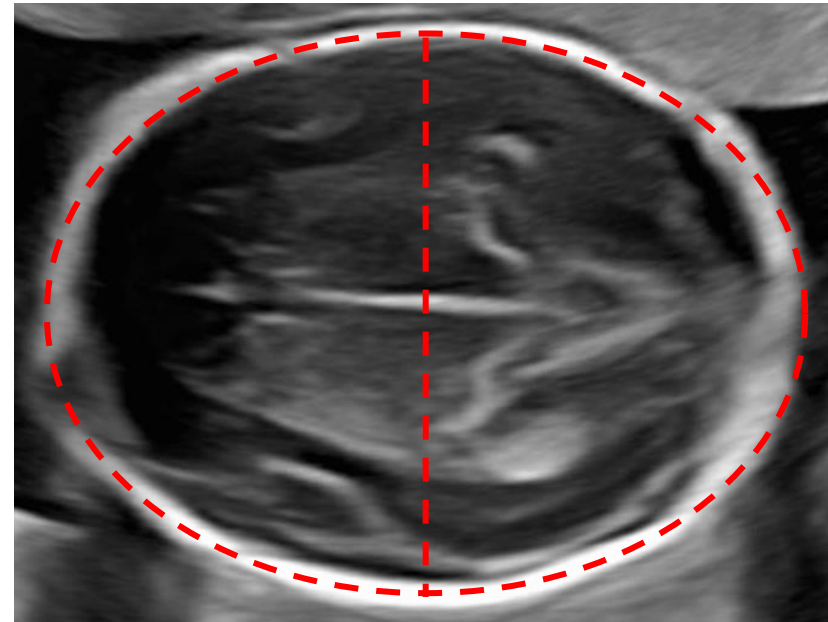


- Landmarks:
  - CSP
  - ventricoli laterali
  - plessi coriodei
- Utilizzata per misurare l'ampiezza del trigono



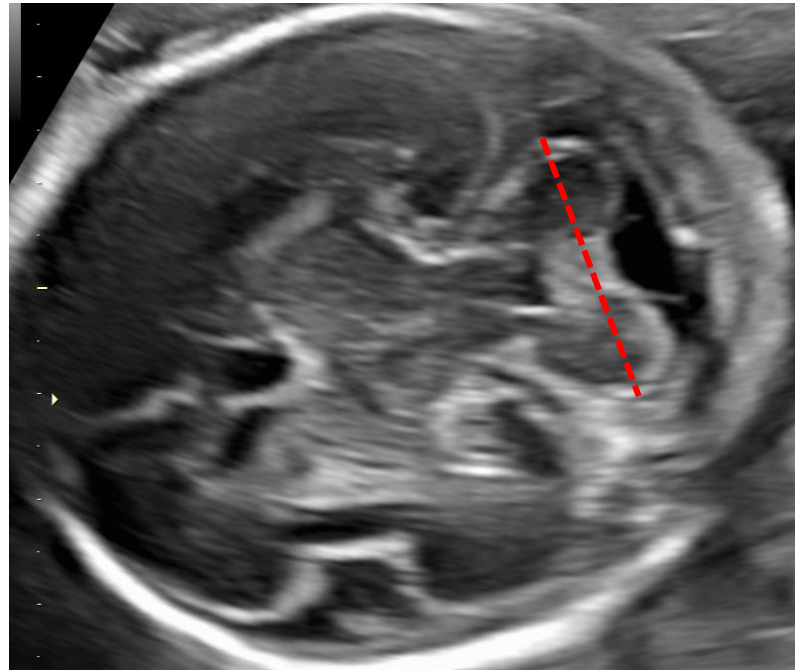
# Scansione transtalamica

- Consente di visualizzare:
  - Teca cranica
  - CSP (fornici)
  - Talami
  - Simmetria degli emisferi cerebrali
- Utilizzata per misura di DBP e CC



# Scansione transcerebellare

- **Consente di visualizzare:**
  - **Cervelletto**
    - Emisferi
    - Verme
    - 4° ventricolo
  - **Cisterna magna**
- **Utilizzata per la misura del DTC**



# Neurosonografia fetale (esame esteso del SNC)

- Esame di riferimento inteso come una ecografia particolarmente approfondita eseguita da medici esperti, con apparecchiature ecografiche di alto livello per approfondire quadri ecografici sospetti evidenziati all'esame di screening, o per condizioni specifiche materne di elevato rischio malformativo fetale
- Come tutti gli esami diagnostici, non può essere eseguito in tutta la popolazione di gestanti, ma solo su specifiche indicazioni materne o fetali



Sonographic examination of the fetal central nervous system:  
guidelines for performing the 'basic examination' and the  
'fetal neurosonogram'

# WAPM-World Association of Perinatal Medicine Practice Guidelines: Fetal central nervous system examination

*Valentina De Robertis, Cihat Sen, Ilan Timor-Tritsch, Rabih Chaoui, Paolo Volpe, Alberto Galindo, Reuven Achiron, Ritsuko Pooh, Asma Khalil, Nicola Volpe, Francesco D'Antonio and Roeer Birnbaum*

From the journal *Journal of Perinatal Medicine*  
<https://doi.org/10.1515/jpm-2021-0183>

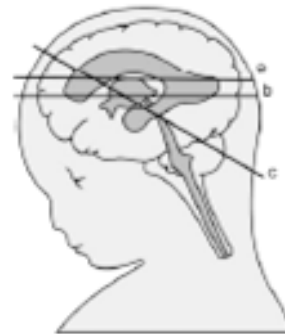
2021

## MANUALE METODOLOGICO PER ECOGRAFIA OSTETRICA E GINECOLOGICA

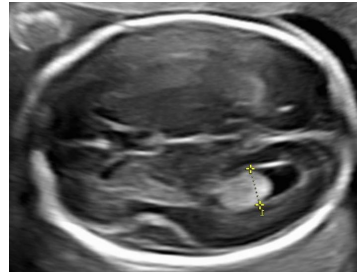
**SIEOG**  
Società Italiana di  
Ecografia Ostetrica  
Ginecologica e  
Metodologie  
Biofisiche



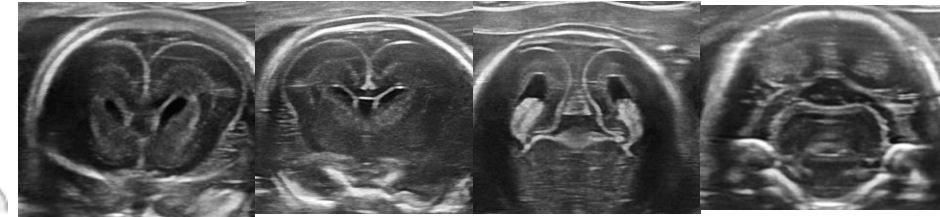
2021



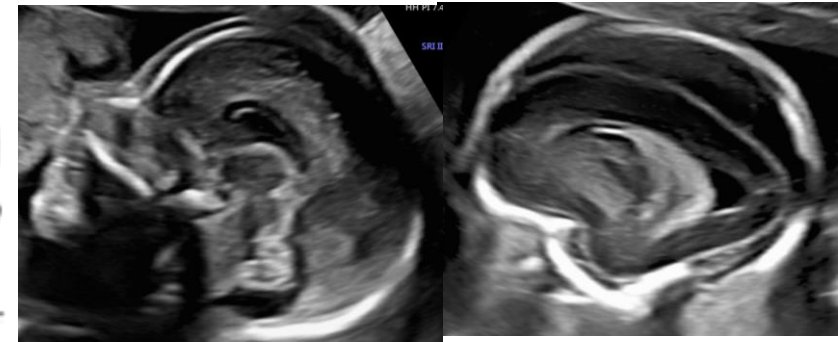
*Axial*



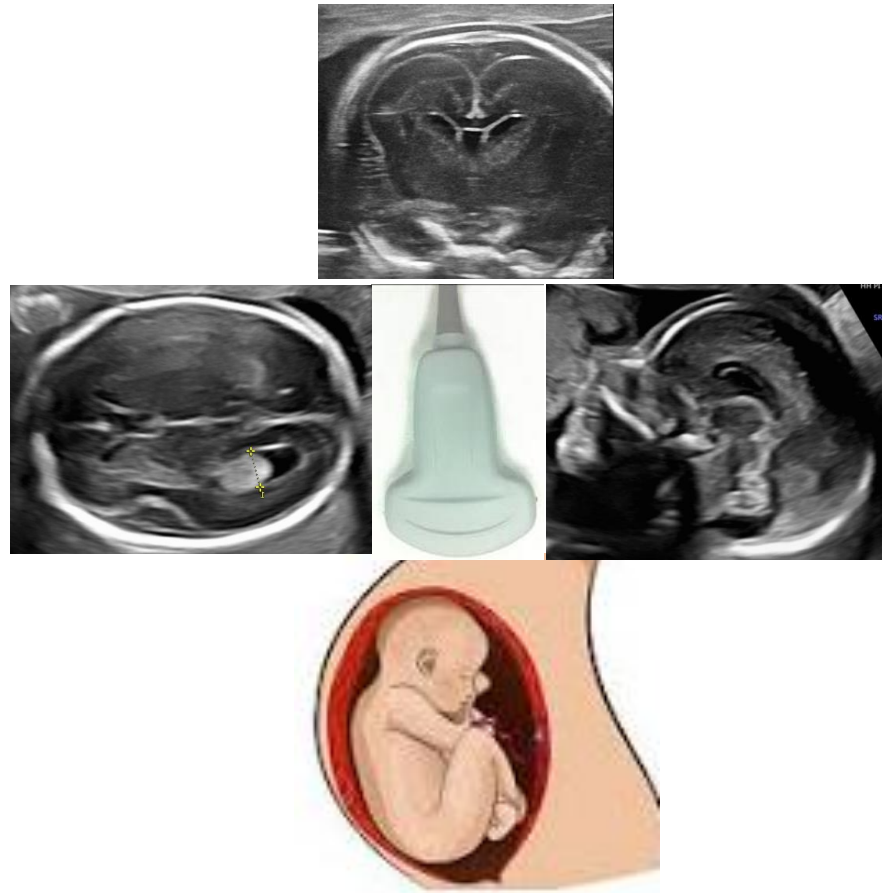
*Coronal*



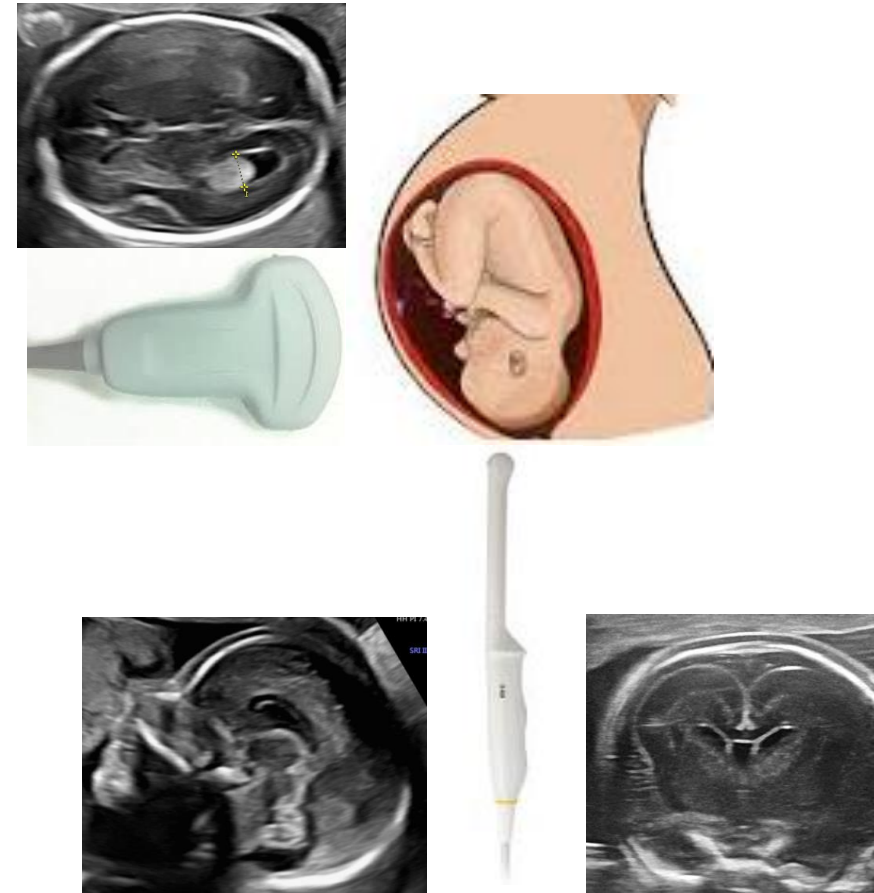
*Sagittal*



## Presentazione podalica

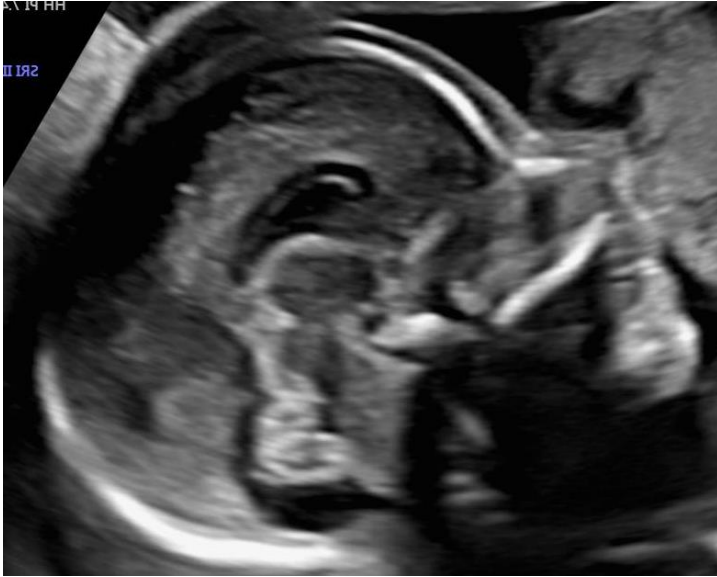


## Presentazione cefalica

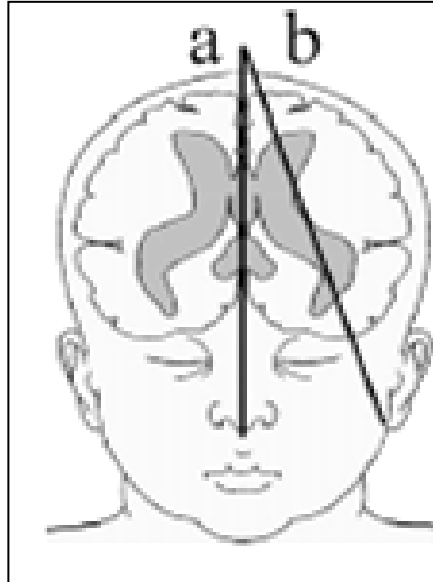


# Scansioni sagittali

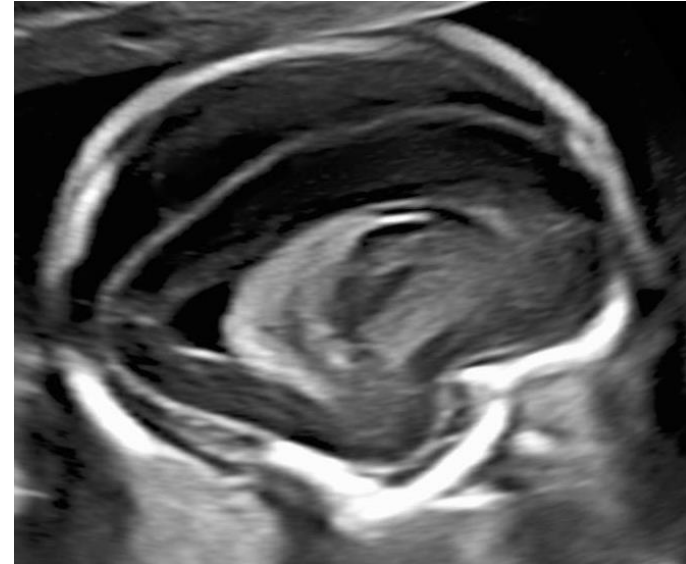
MEDIANA



- Corpo calloso
- CSP e CV
- Lamina quadrigemina
- Terzo ventricolo
- Tronco encefalico
- Verme cerebellare
- Quarto ventricolo
- Cisterna magna

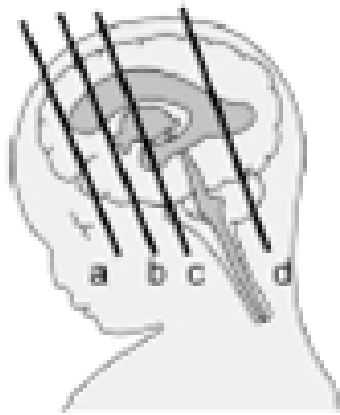


PARAMEDIANA

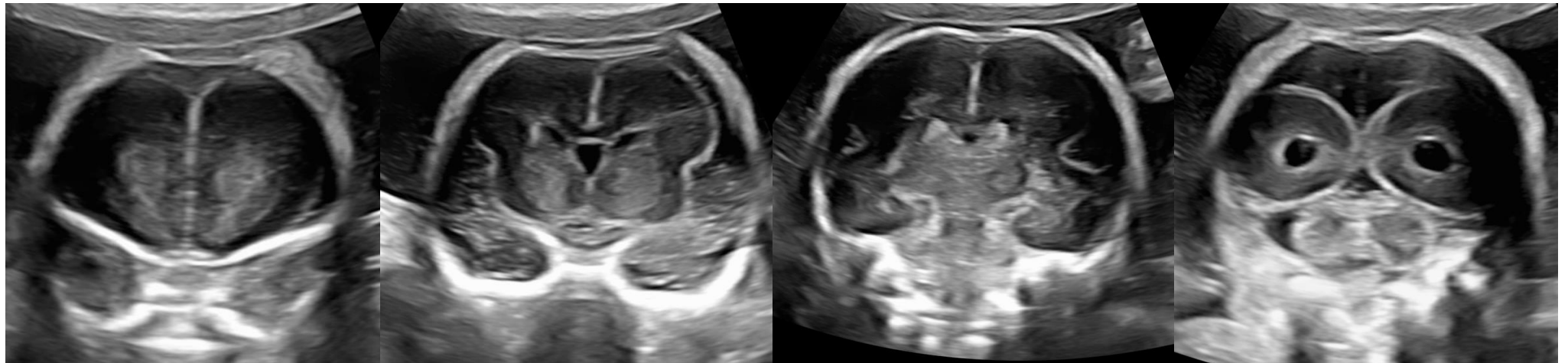


- 3 horns view
- Plesso coriideo
- Tessuto periventricolare
- Corteccia cerebrale
- Spazi aracnoidei





# Scansioni coronali



**Transfrontale**

**Transcaudata**

**Transtalamica**

**Transcerebellare**

- Scissura interemisferica
- Lobi frontali
- Orbite

- Scissura interemisferica
- Corni frontali
- CSP
- Corpo calloso
- Nuclei caudati
- Scissura Silviana

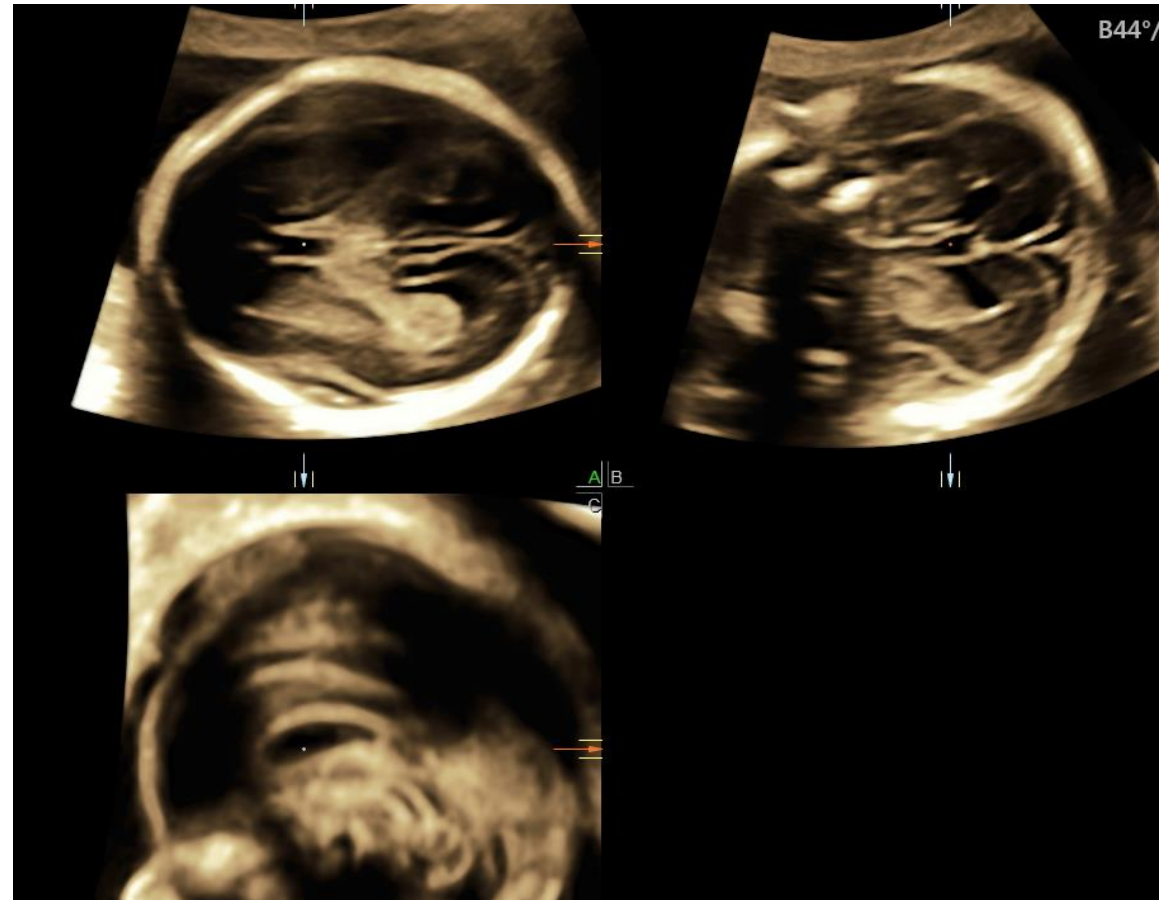
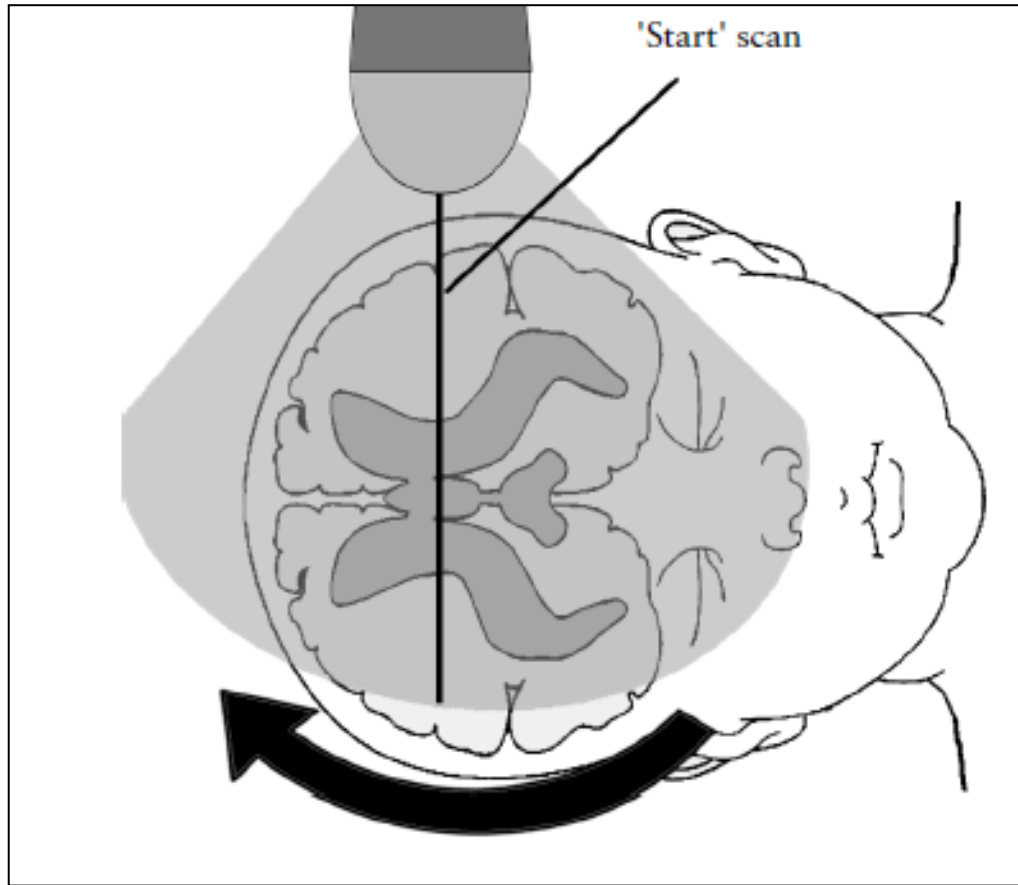
- Scissura interemisferica
- Ventricoli laterali
- Forami di Monro
- Terzo ventricolo
- Talami

- Corni posteriori
- Cervelletto

# Ecografia 3D

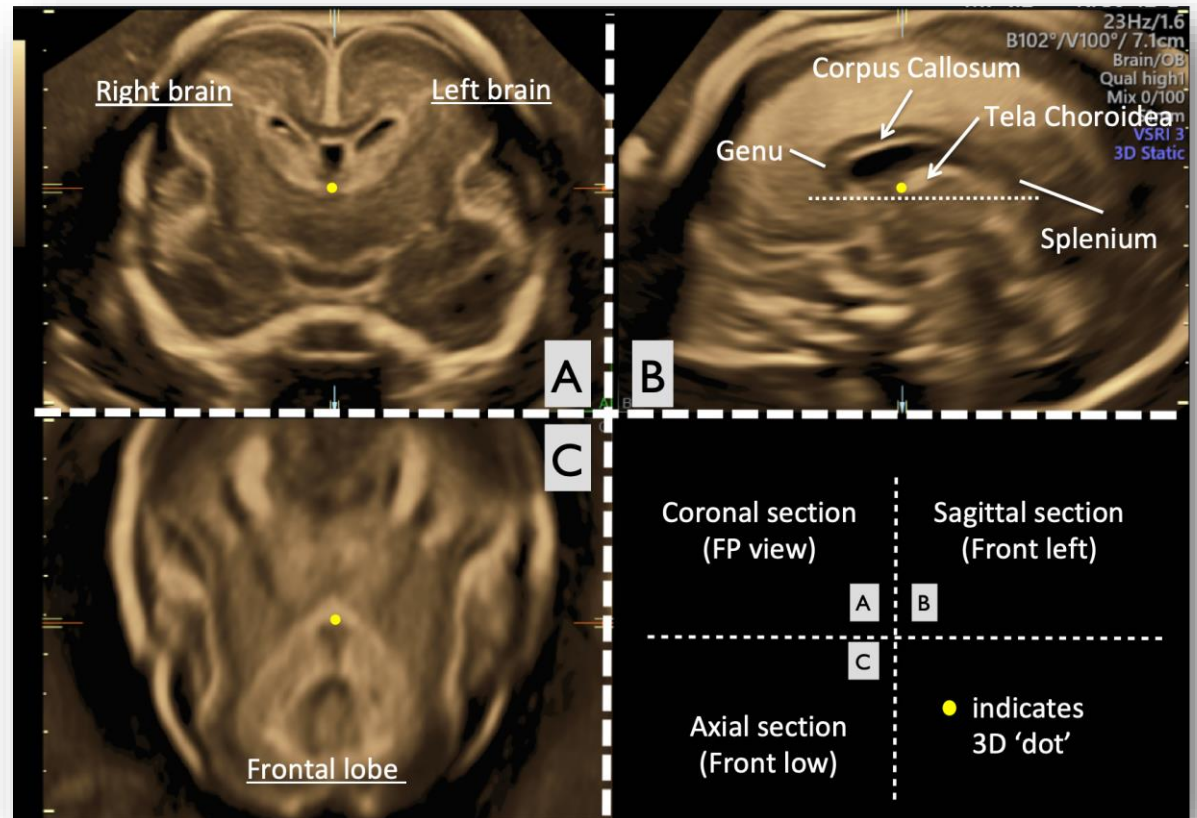
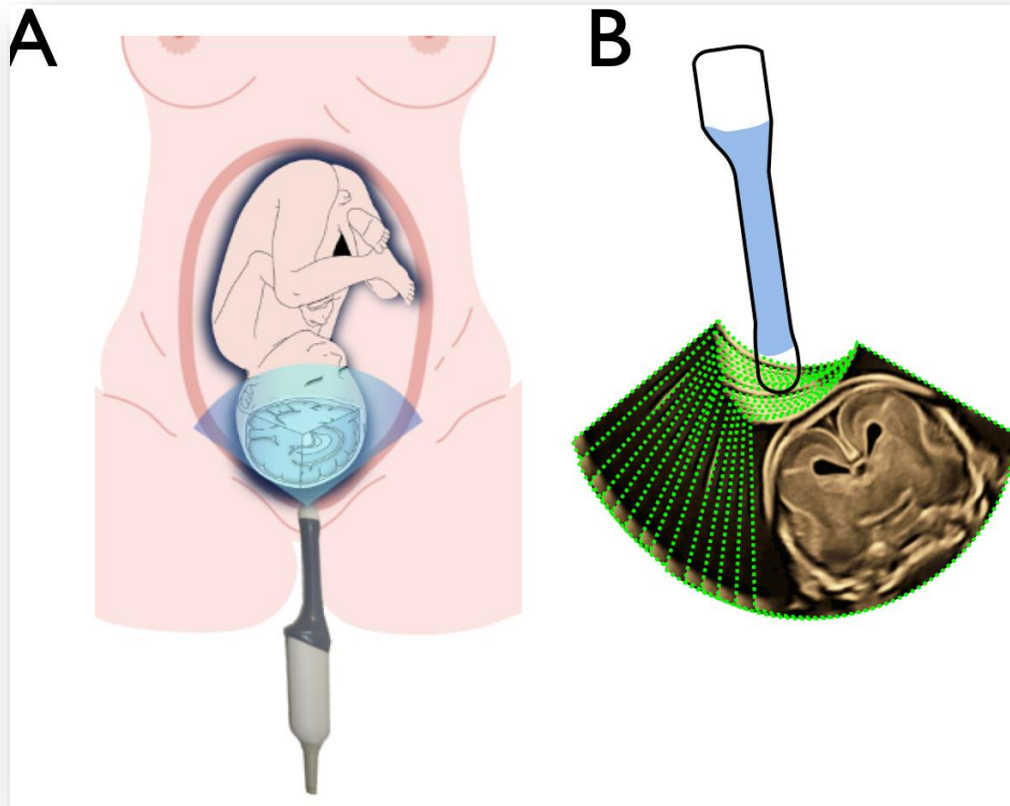
- Possibilità di navigare su un numero illimitato di sezioni all'interno di un dataset volumetrico
- Possibilità di applicare diversi algoritmi di rendering
- Possibilità di rivedere e misurare anche off-line le strutture
- Potenzialità di una standardizzazione dell'esame ecografico
- Trasmissione dei dati per consulenza a Centro di riferimento

# 3D multiplanare TA

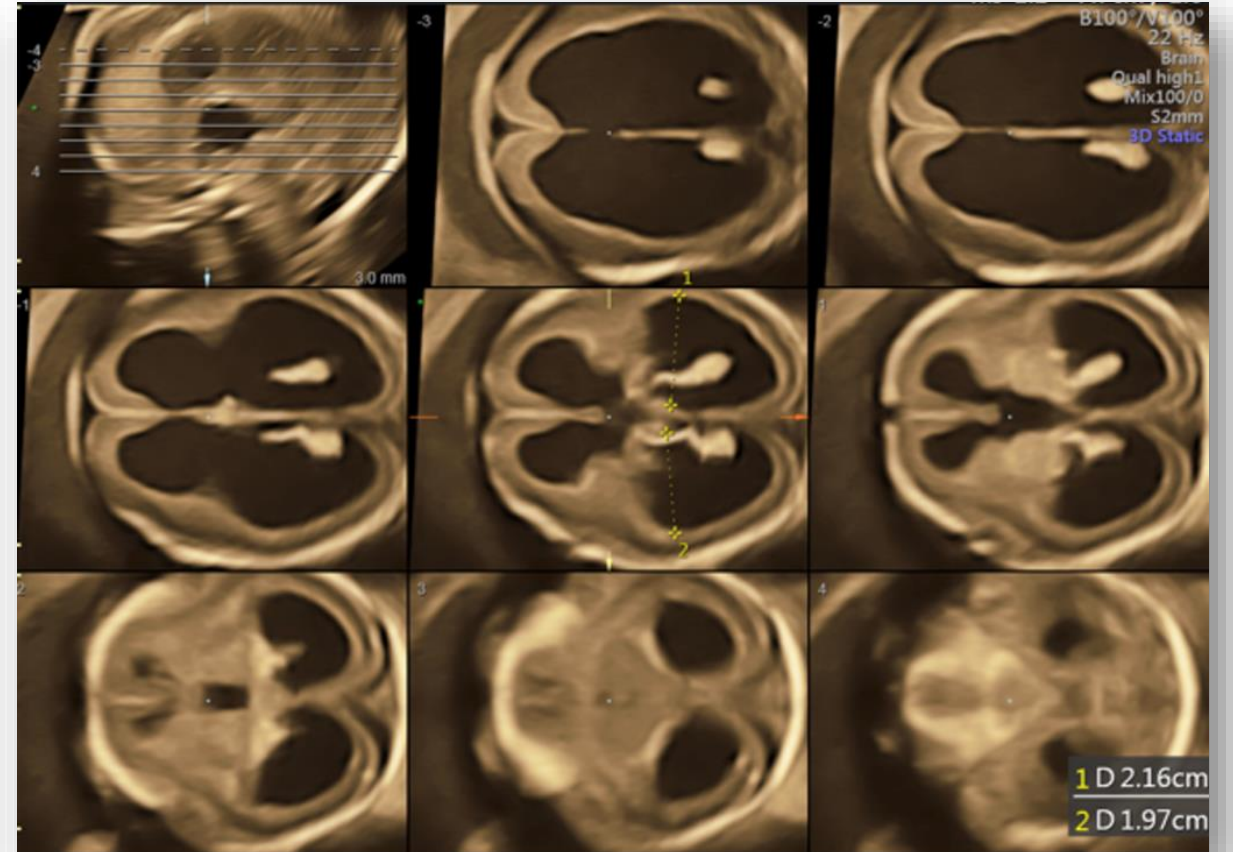
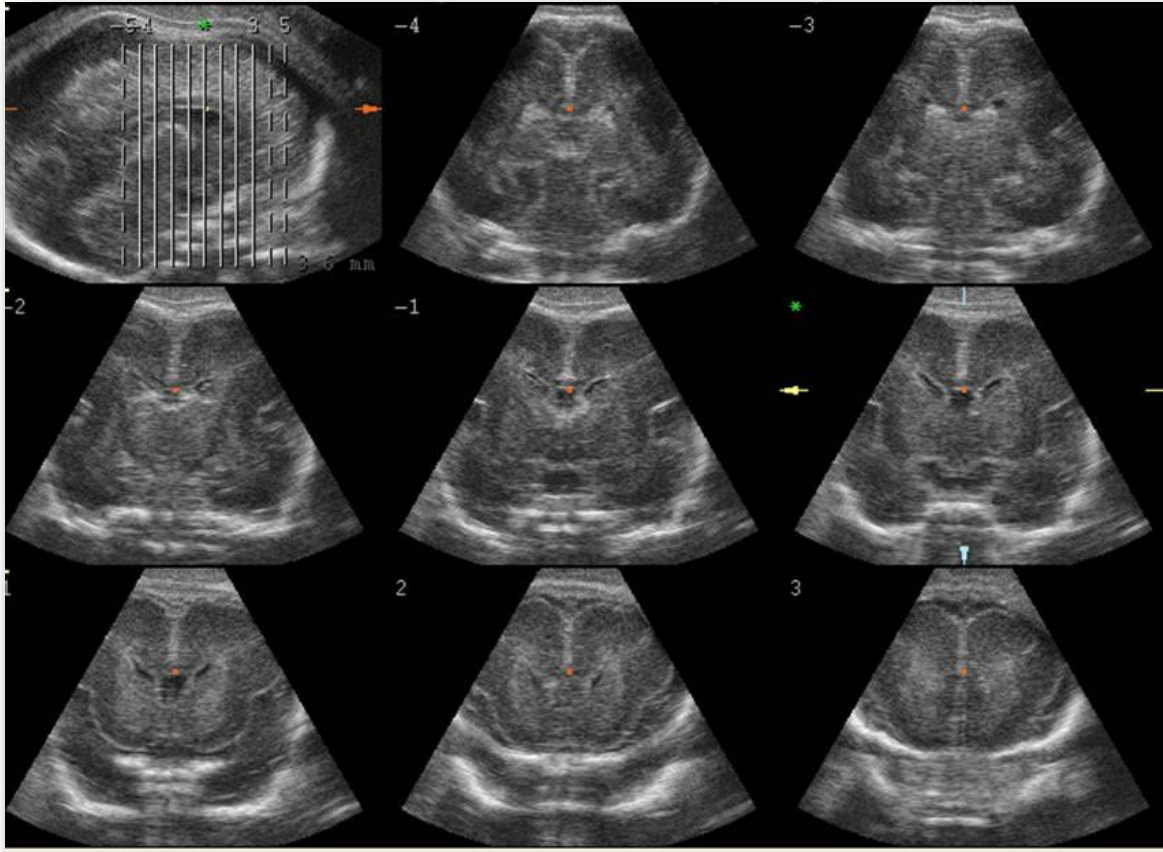




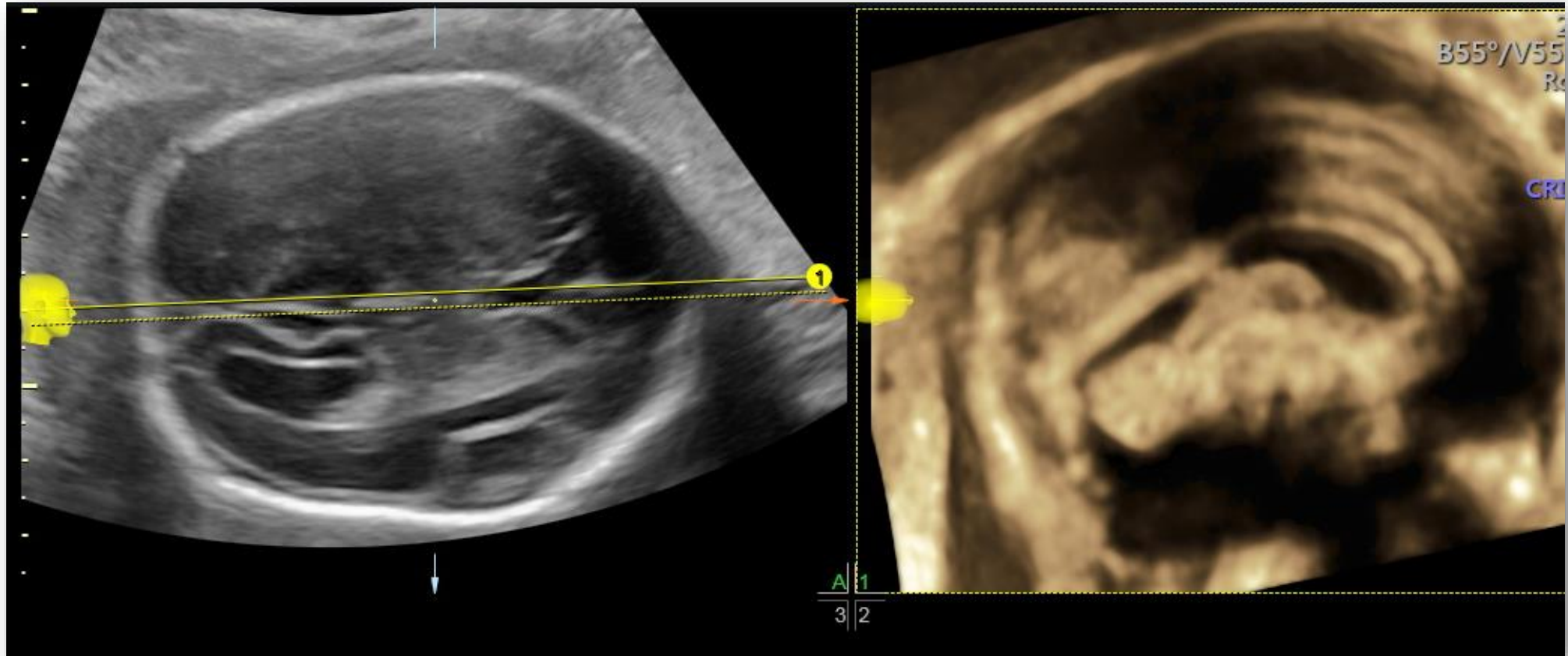
# 3D multiplanare TV



# Tomographic Ultrasonic Imaging

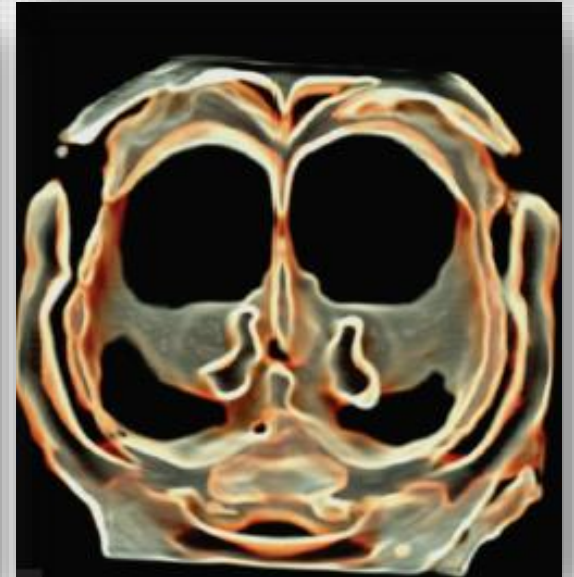
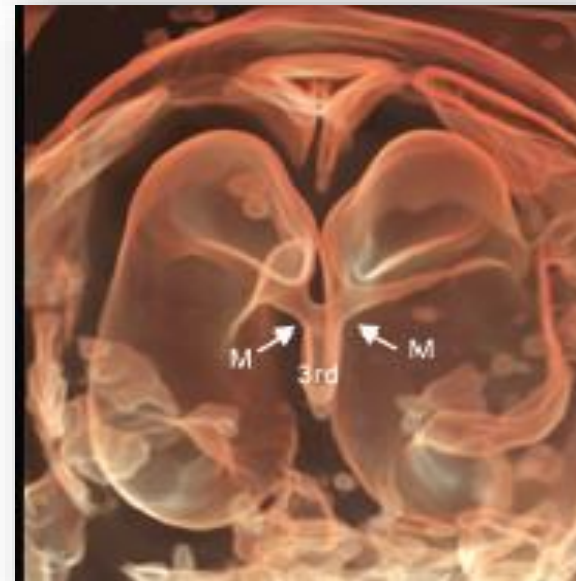
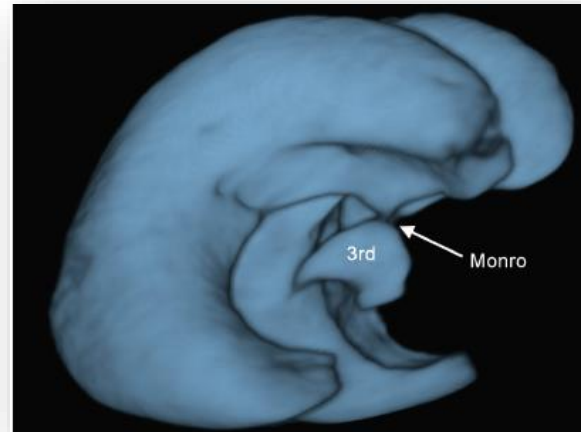


# OMNIVIEW

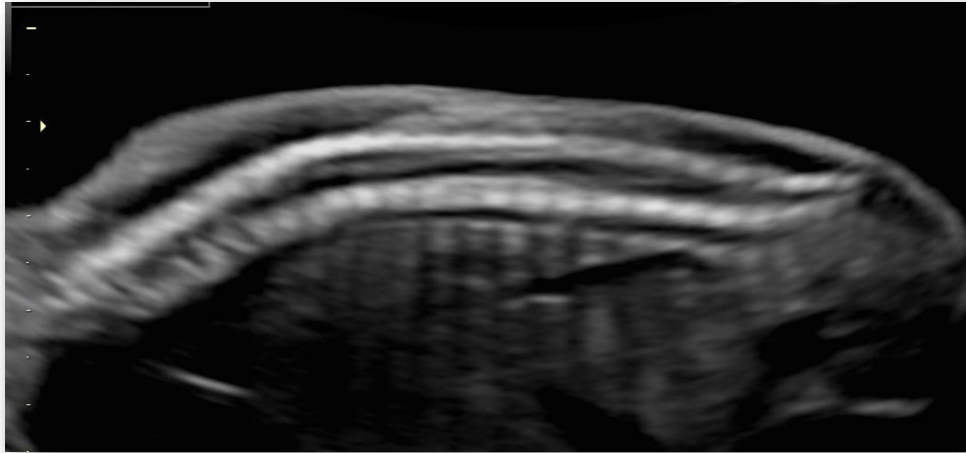




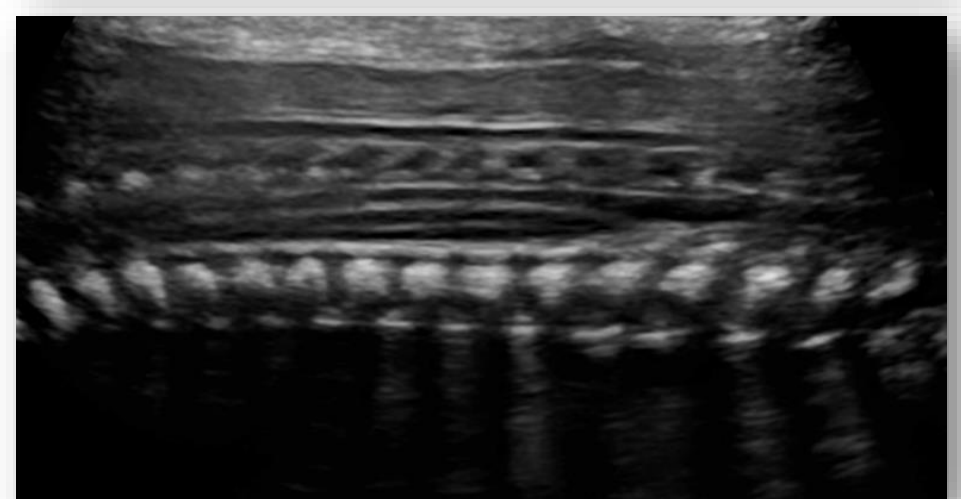
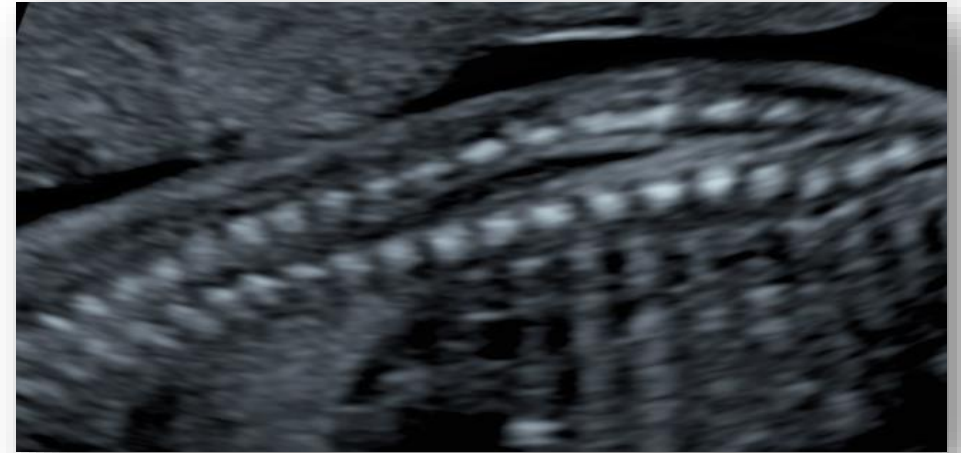
- *Inversion mode*
- *HD live*
- *HD live silhouette*
- *Thick-slice silhouette*



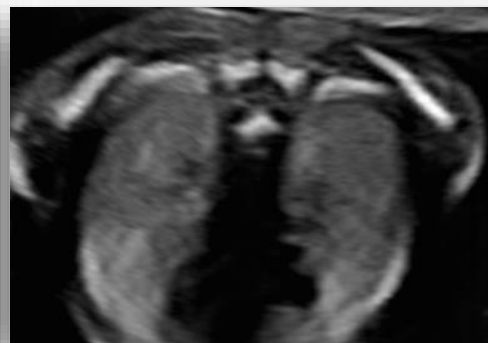
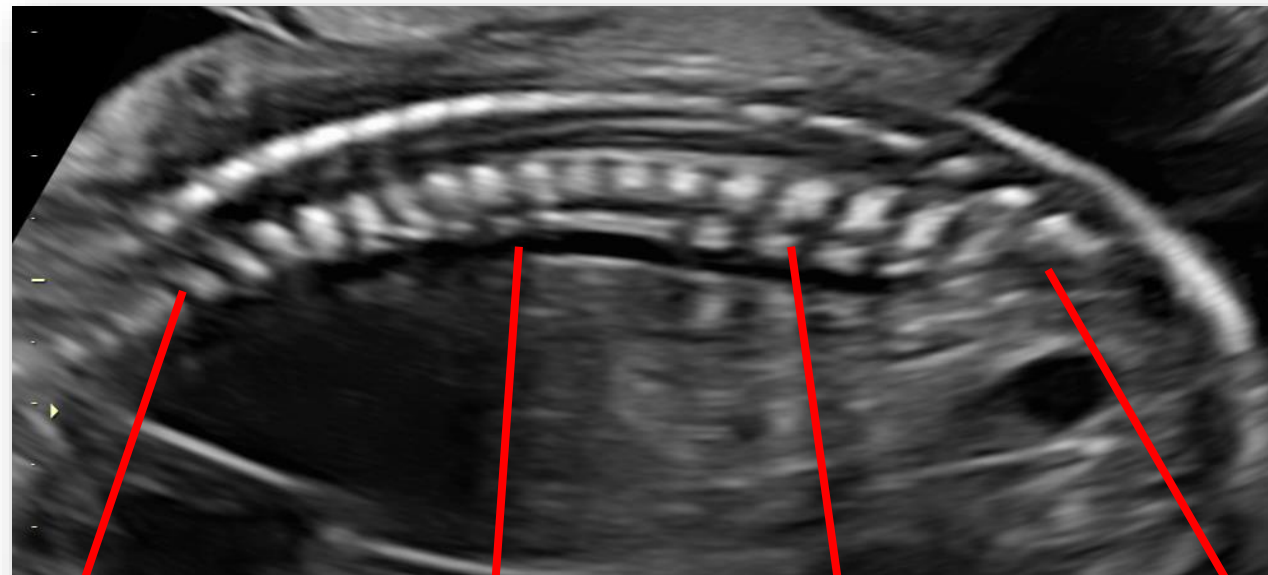
# Screening



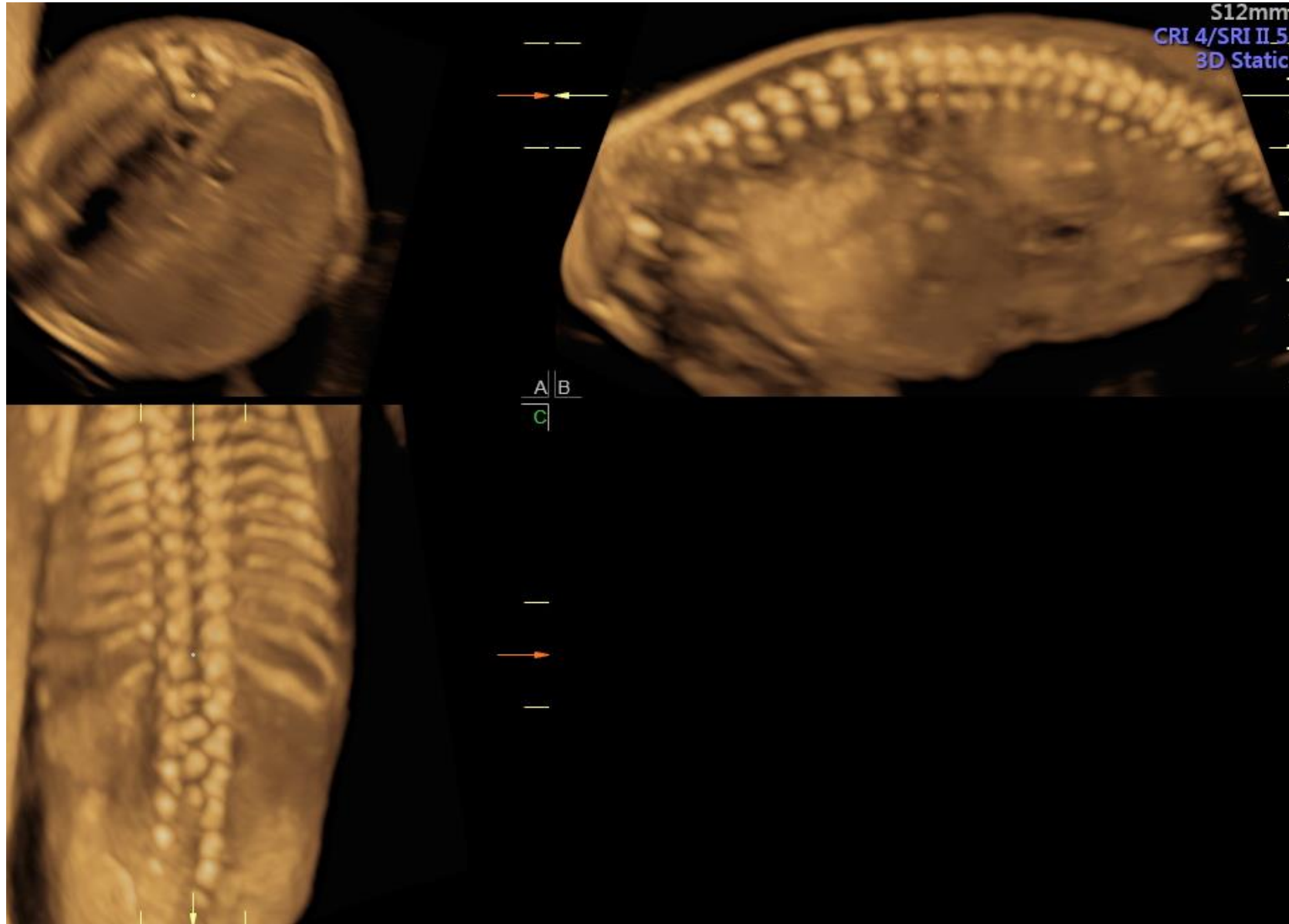
# Approfondimento



# Scansioni assiali

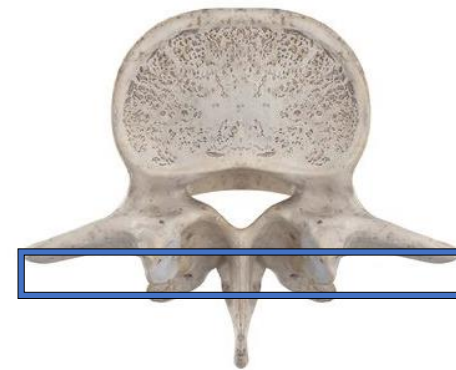
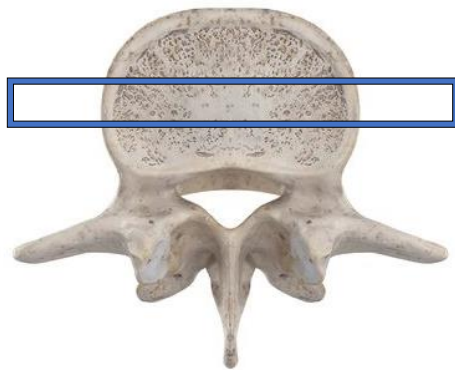
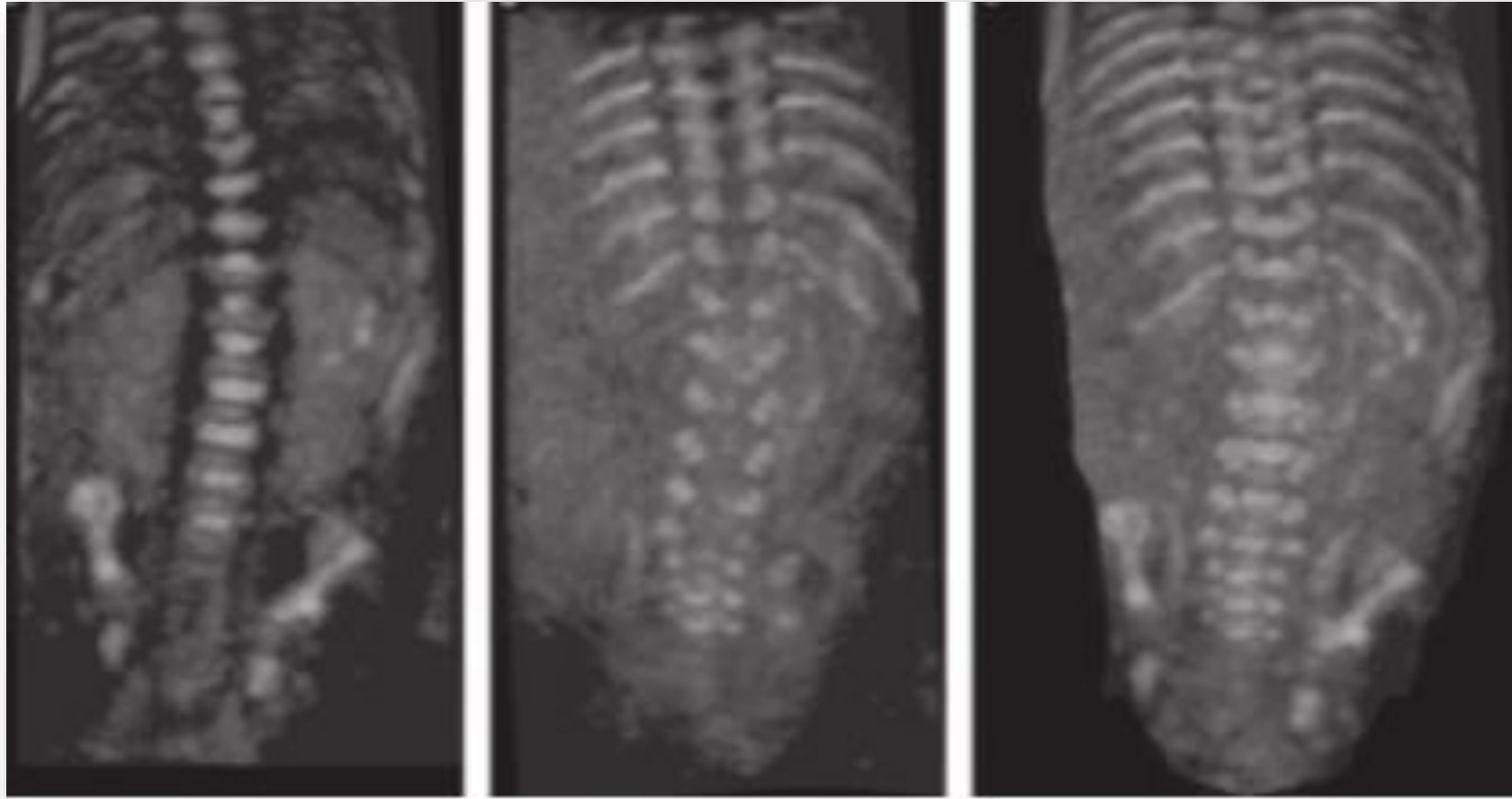


# 3D multiplanare



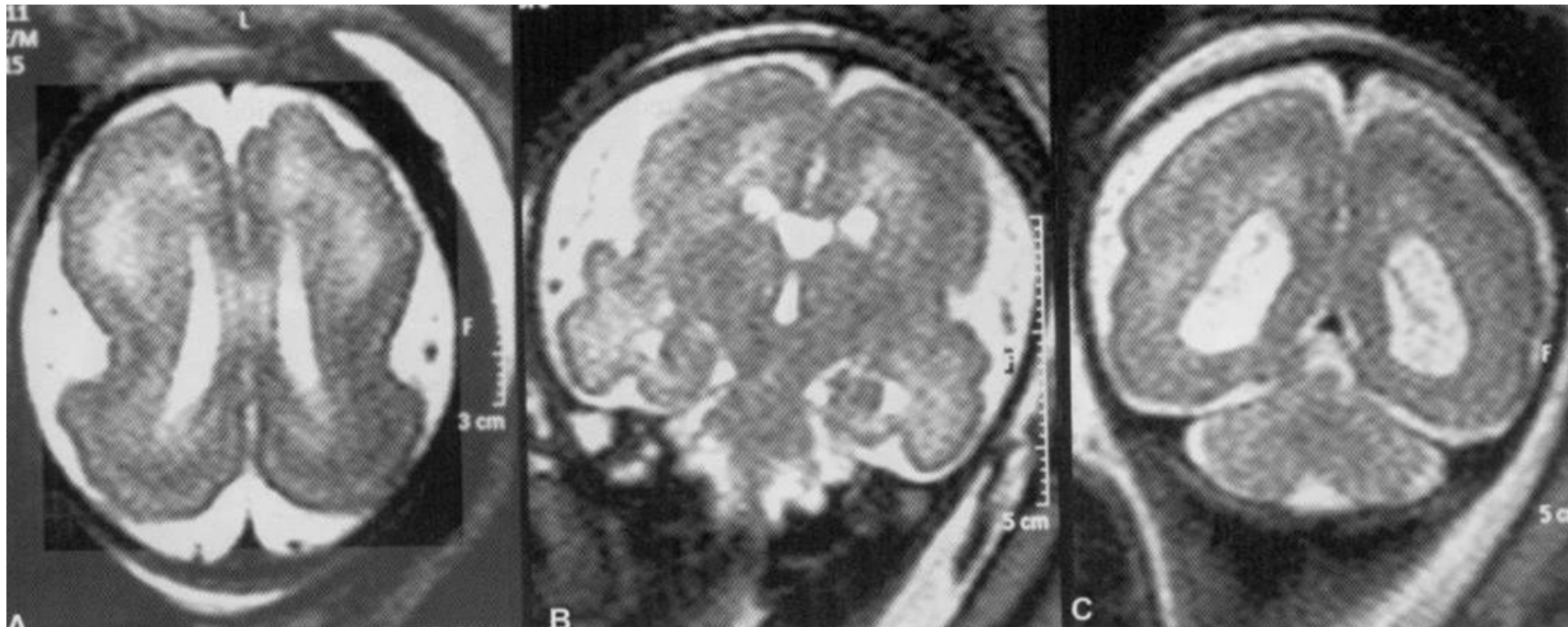


# 3D rendering in coronale



# Neurosonografia fetale : limiti

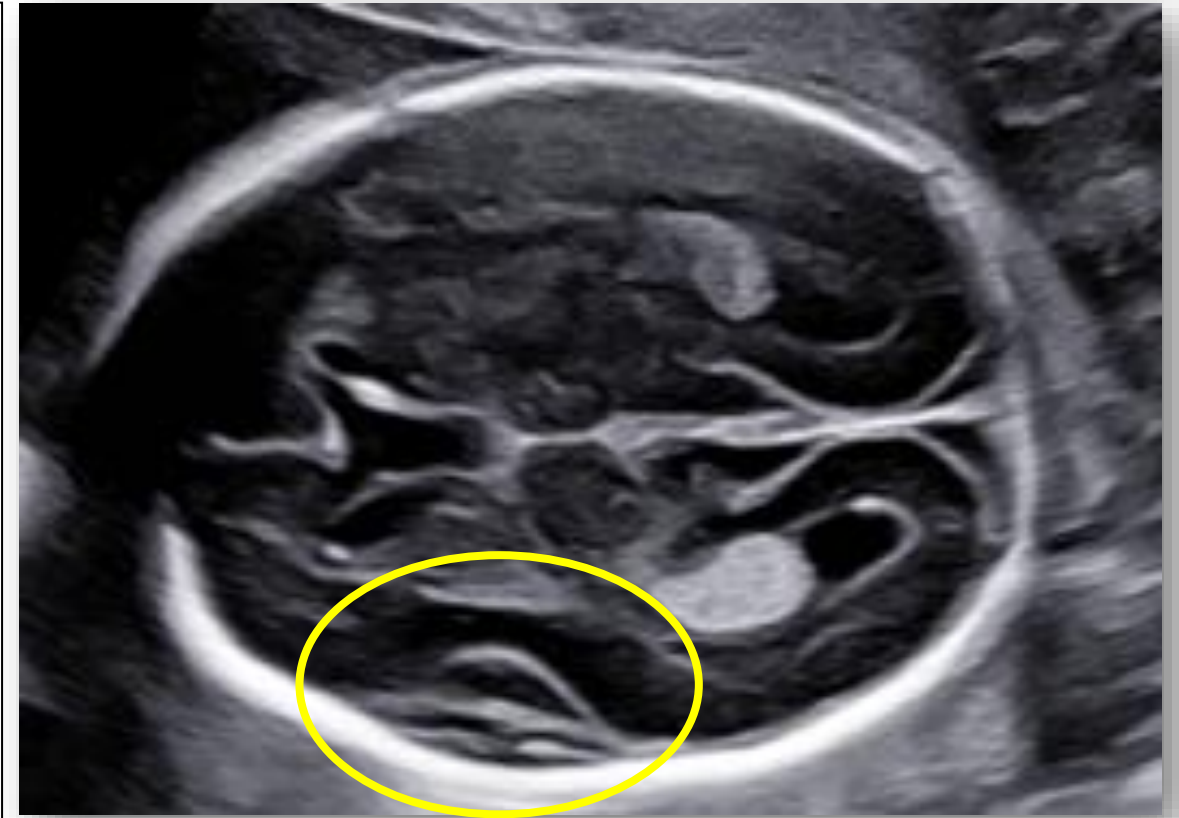
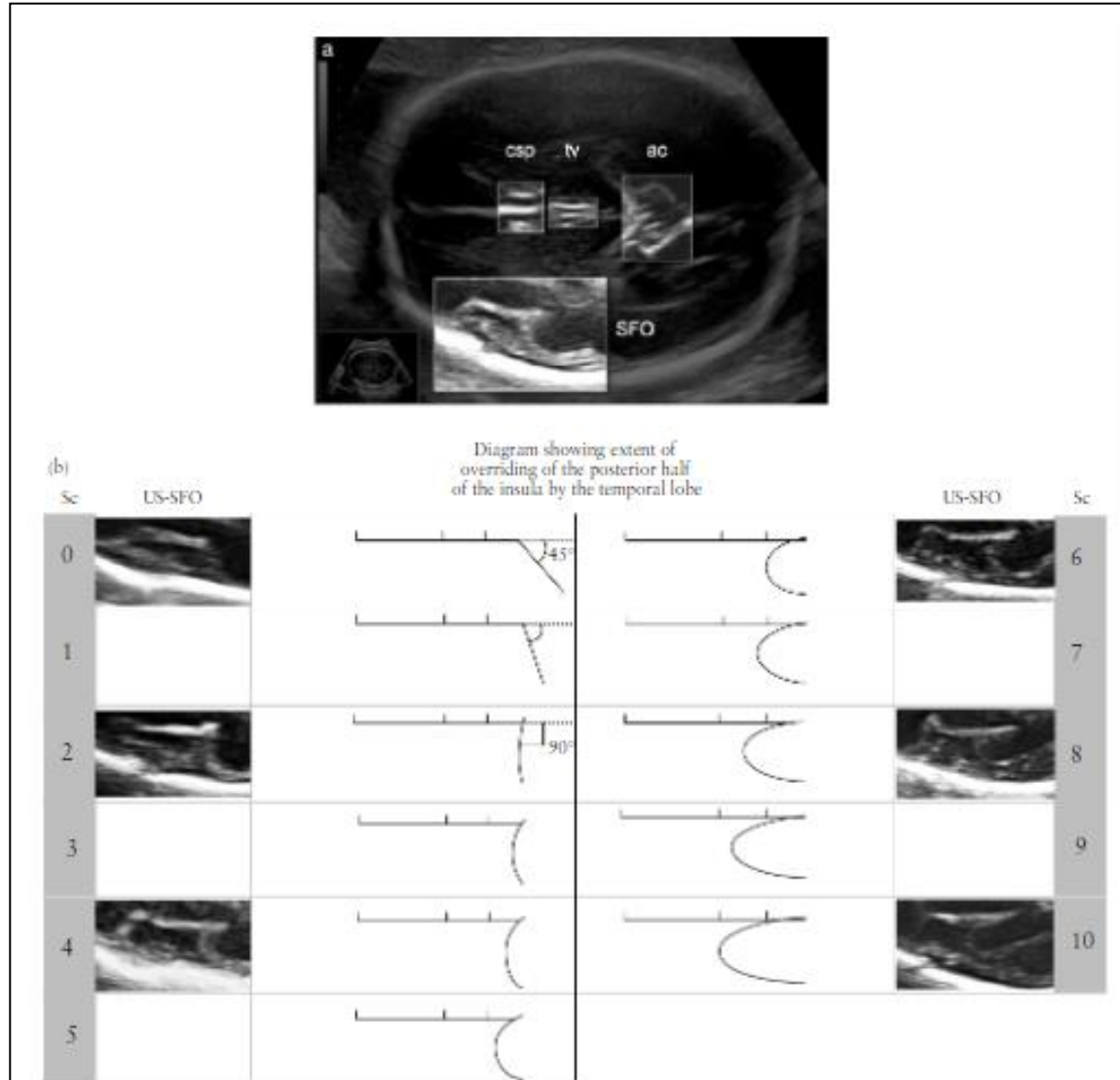
- Valutazione dei processi di girazione
- Lesioni parenchimali



# Assessment of fetal Sylvian fissure operculization between 22 and 32 weeks: a subjective approach

E. QUARELLO\*, J. STIRNEMANN\*, Y. VILLE\* and L. GUIBAUD†

UOG 2008

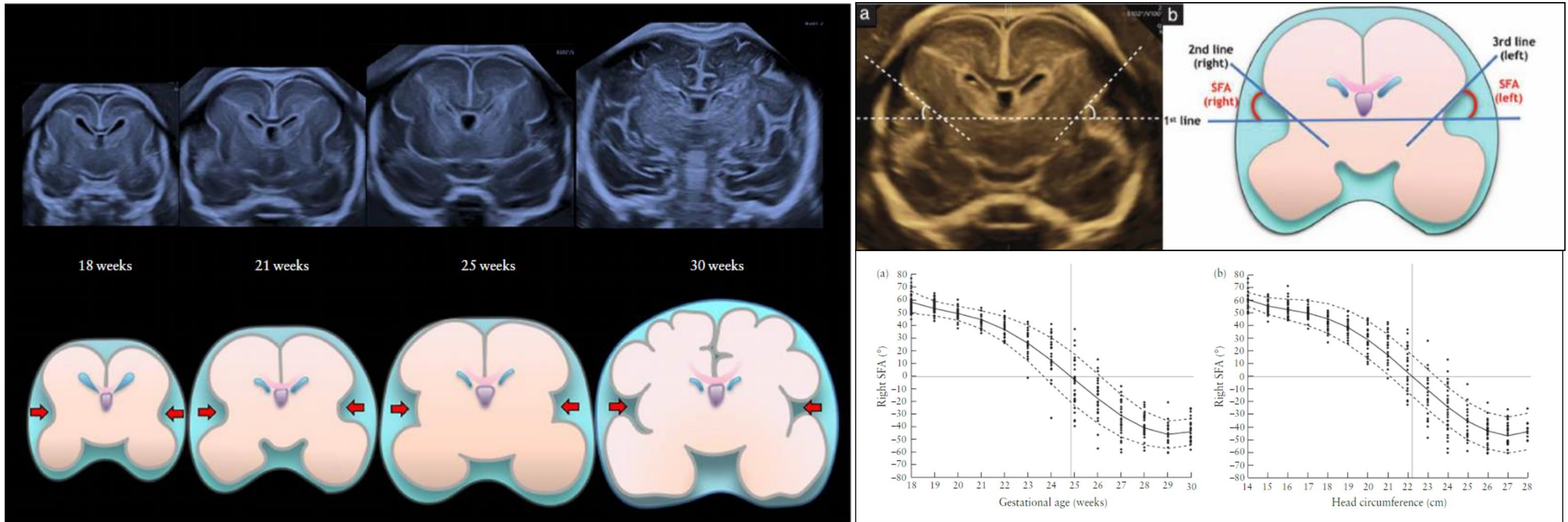


Scissura Sylviana

# Transvaginal three-dimensional ultrasound assessment of Sylvian fissures at 18–30 weeks' gestation

L. C. POON<sup>1</sup>, D. S. SAHOTA<sup>1</sup>, P. CHAEMSAITHONG<sup>1</sup>, T. NAKAMURA<sup>2</sup>, M. MACHIDA<sup>2</sup>, K. NARUSE<sup>3</sup>, Y. M. WAH<sup>1</sup>, T. Y. LEUNG<sup>1</sup> and R. K. POOH<sup>2</sup>

UOG 2019

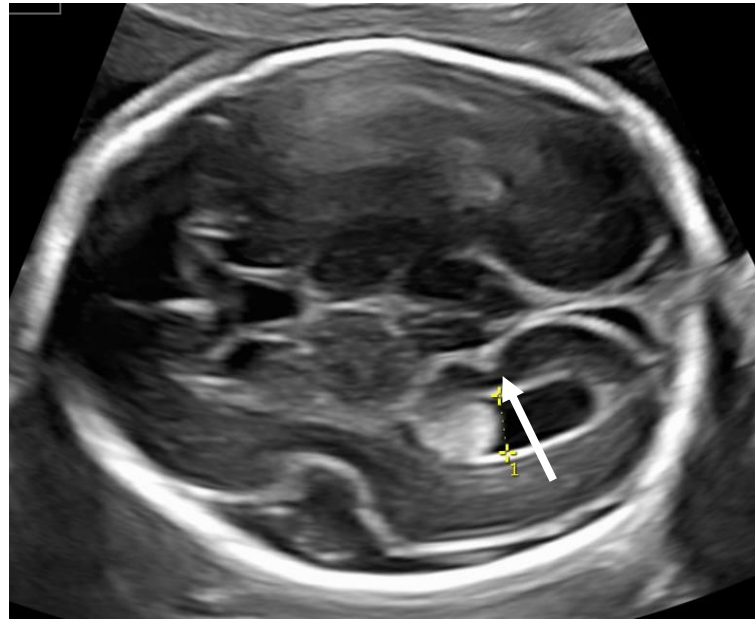




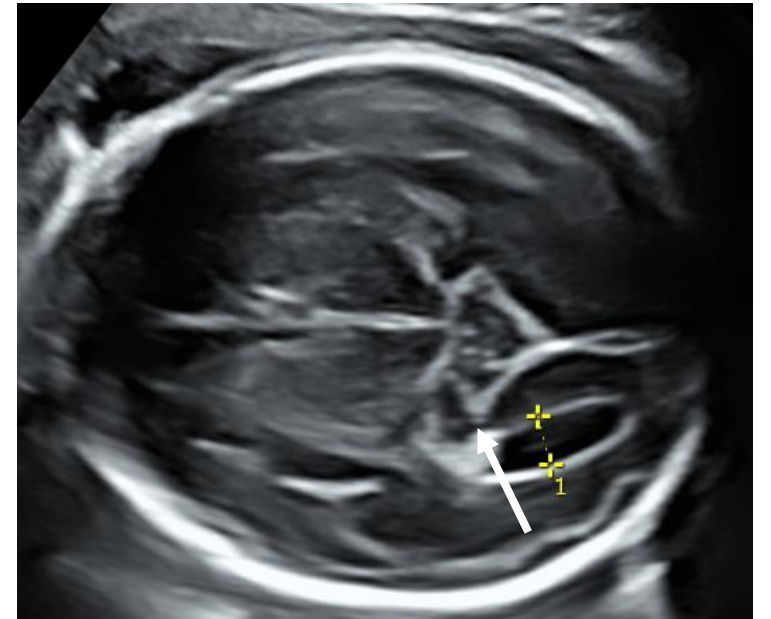
# Scissura parieto-occipitale



19 wks



22 wks



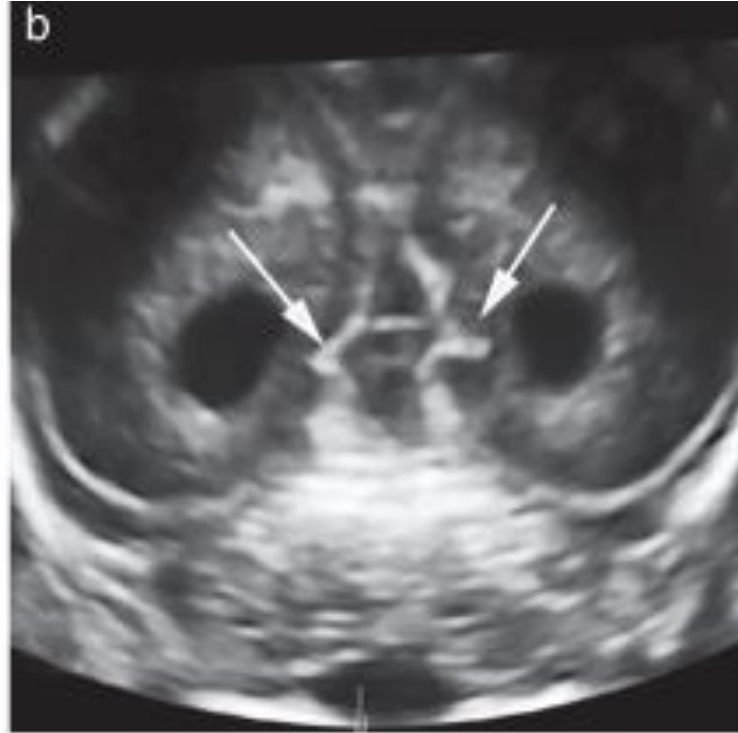
29 wks



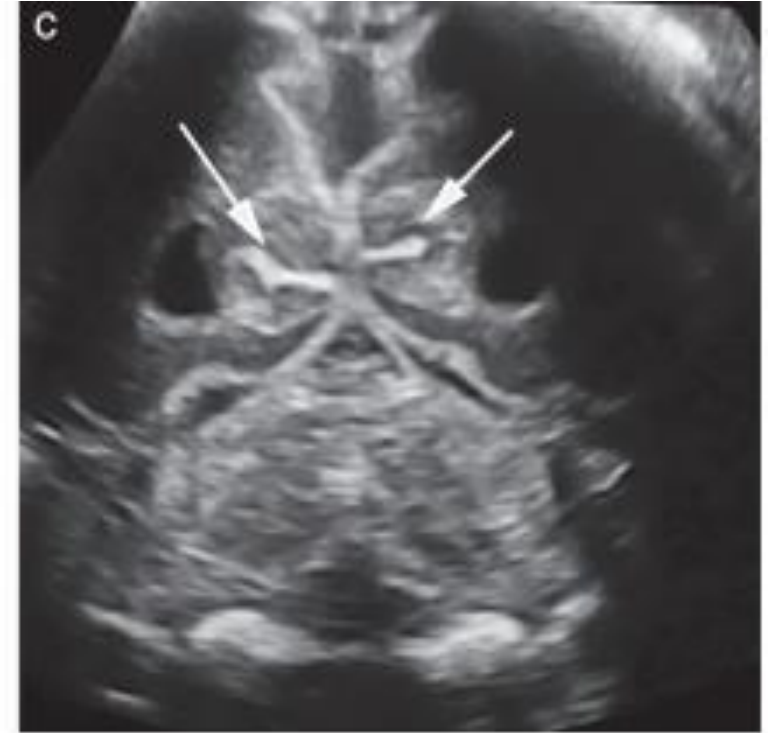
# Scissura calcarina



21 wks

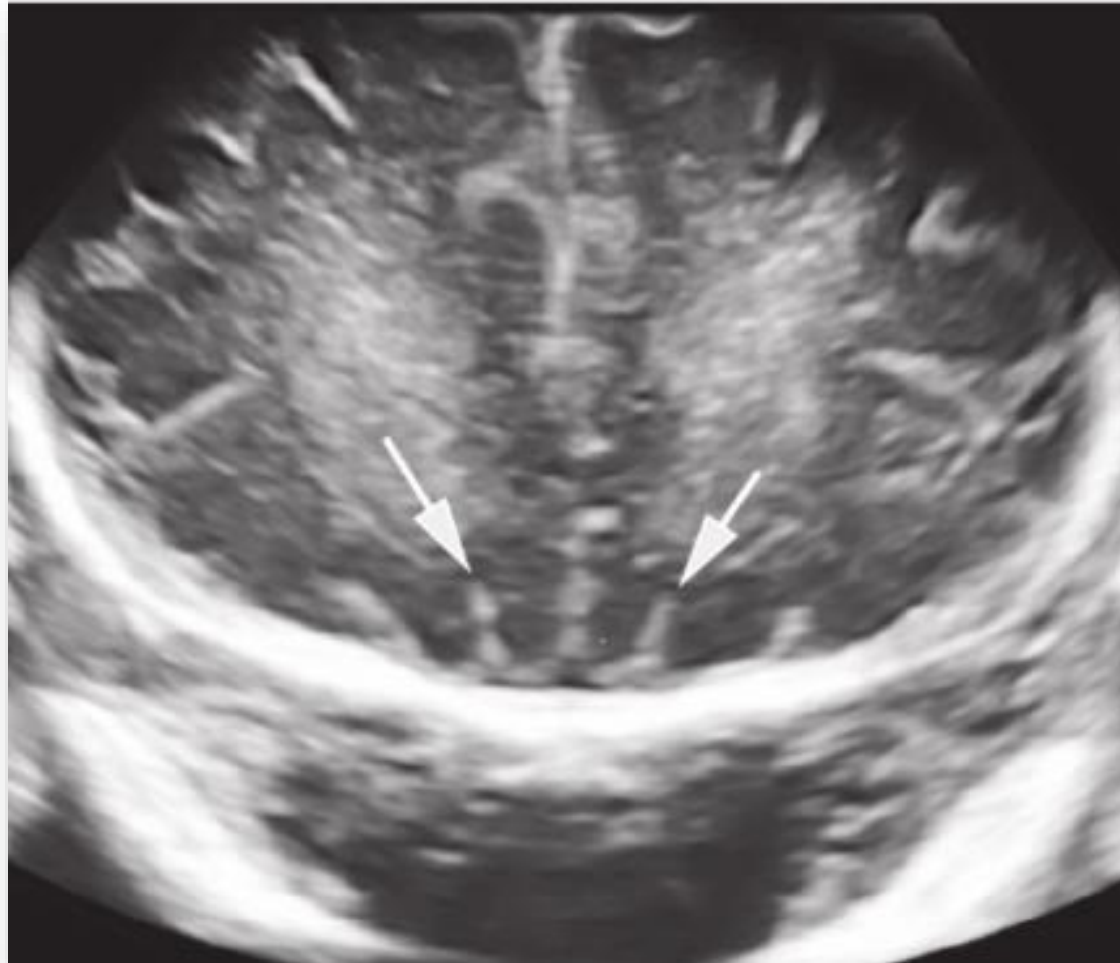


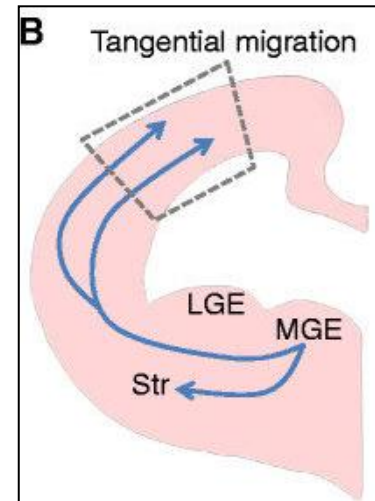
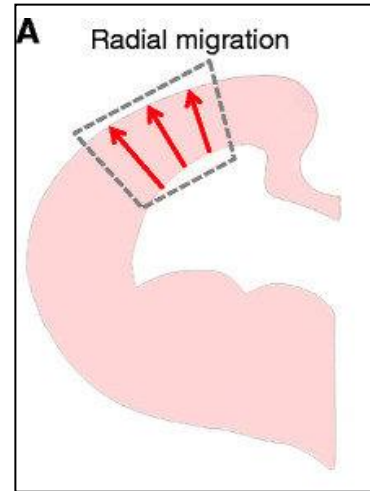
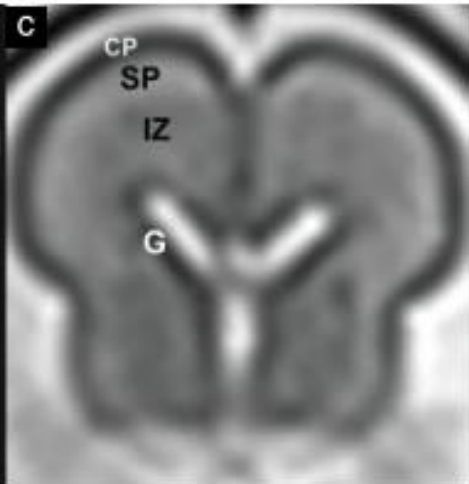
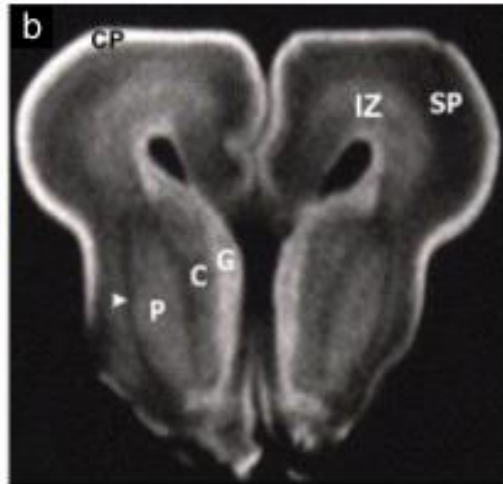
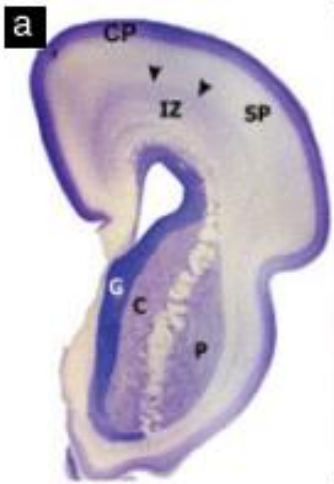
26 wks



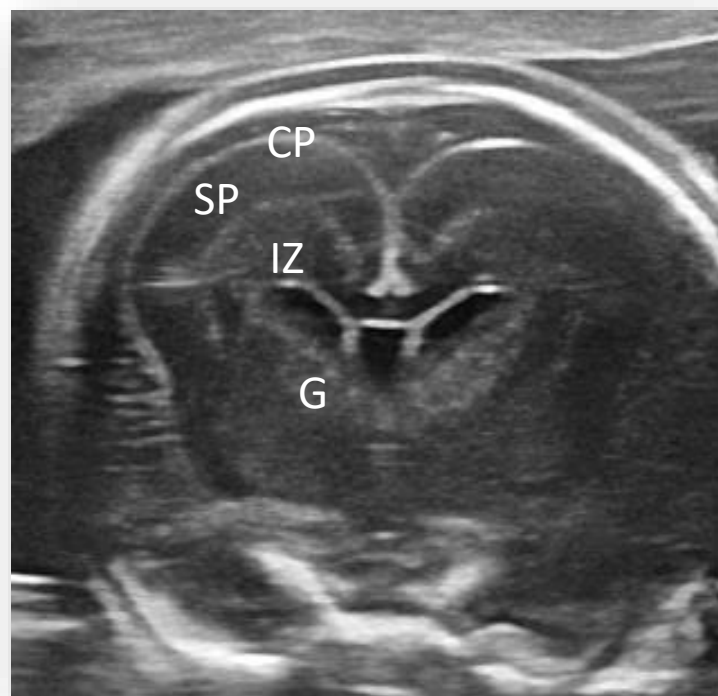
31 wks

# Solci olfattori (dopo 26 settimane)

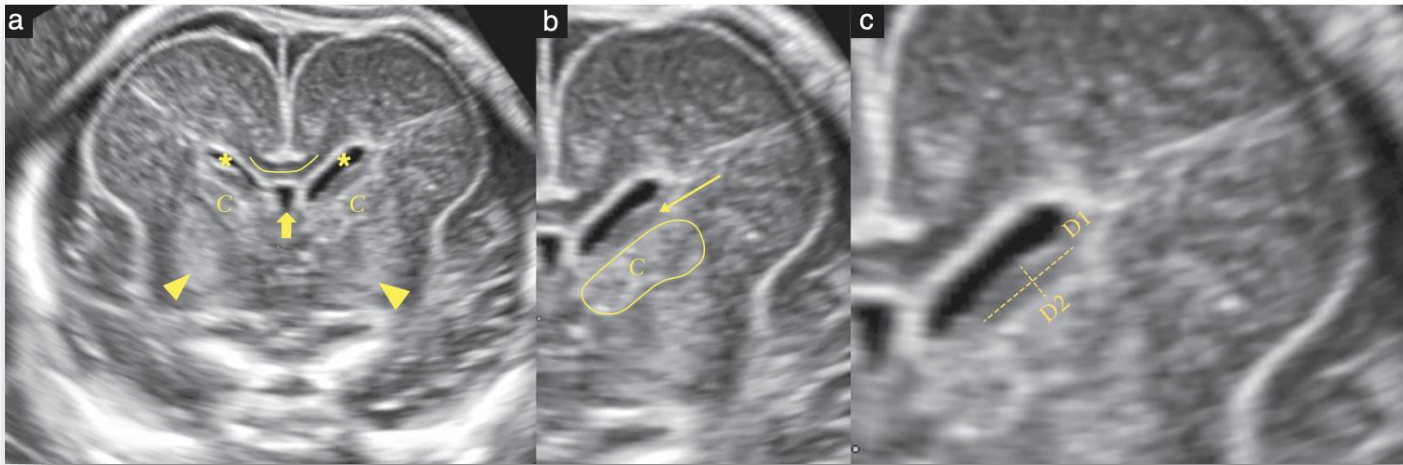




## Zona periventricolare

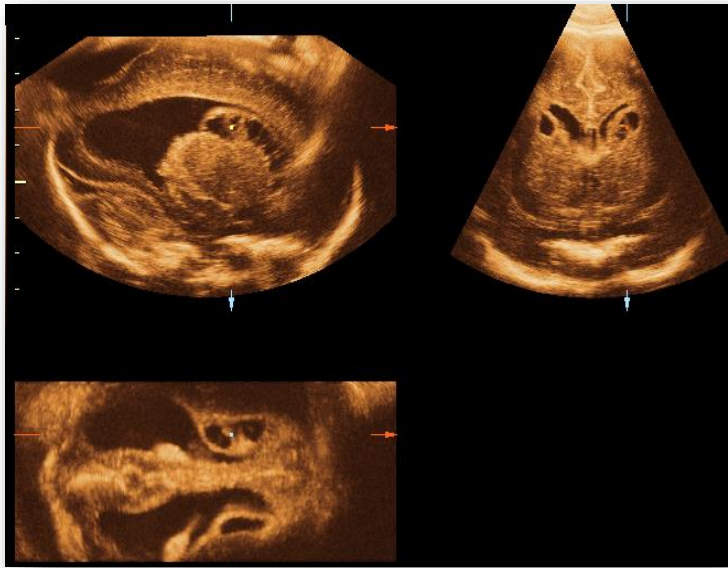


*G* : zona germinativa  
 IZ: zona intermedia  
 SP: piatto sottocorticale  
 CP: piatto corticale

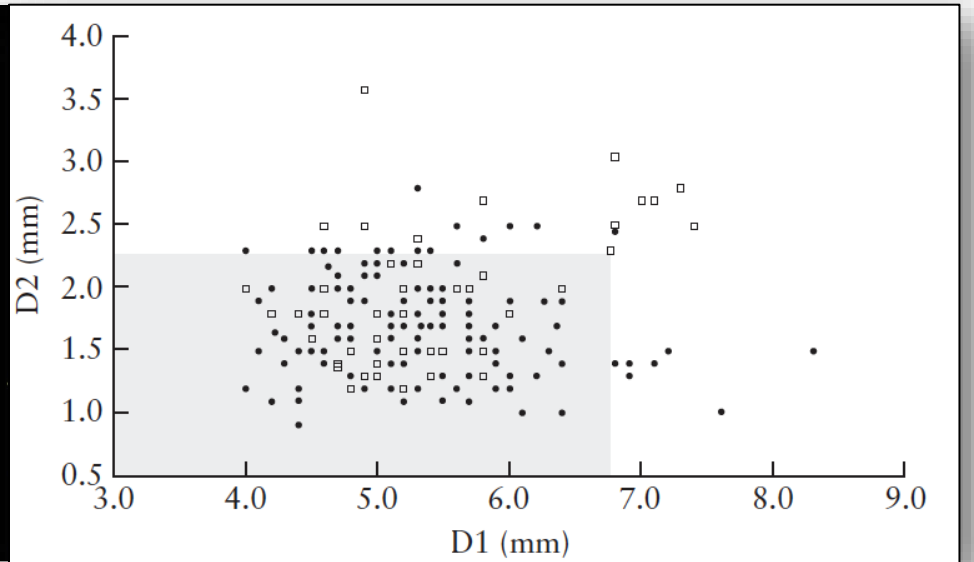
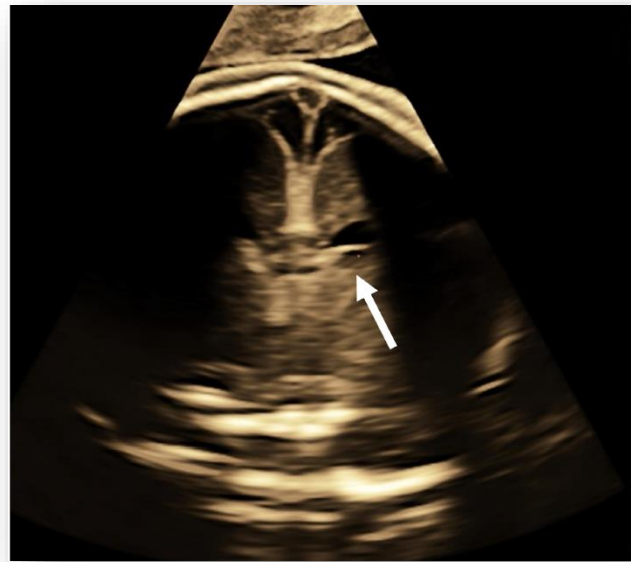


**Normal and abnormal appearance of fetal ganglionic eminence on second-trimester three-dimensional ultrasound**

E. CONTRO<sup>1</sup>, N. VOLPE<sup>2</sup>, L. LARCHER<sup>1</sup>, A. DALL'ASTA<sup>2</sup>, M. A. PENAS DA COSTA<sup>2</sup>, G. VAIRO<sup>1</sup>, E. DI PASQUO<sup>2</sup>, I. GIORGINI<sup>1</sup> and T. GHI<sup>2</sup>  
 UOG 2023

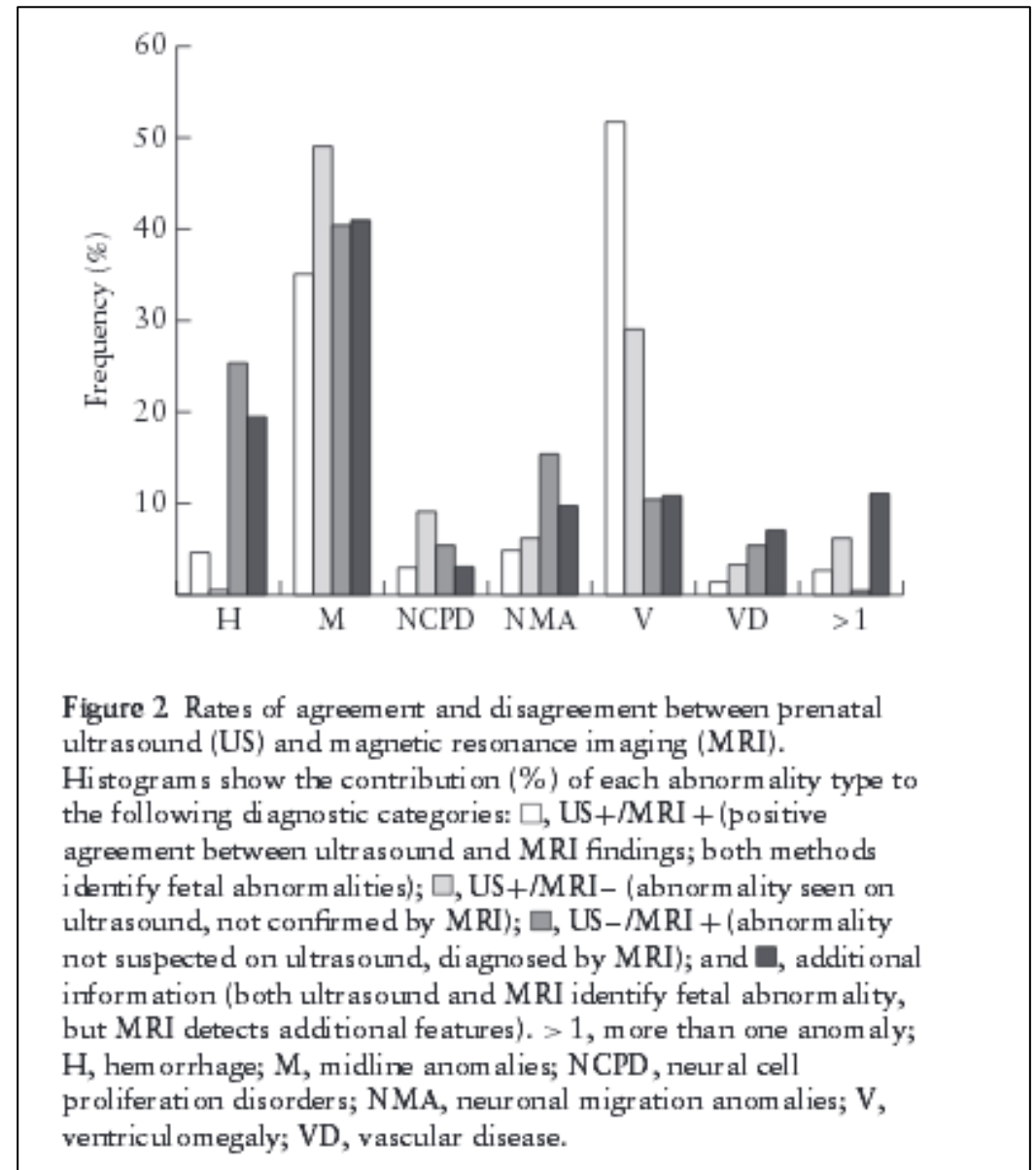
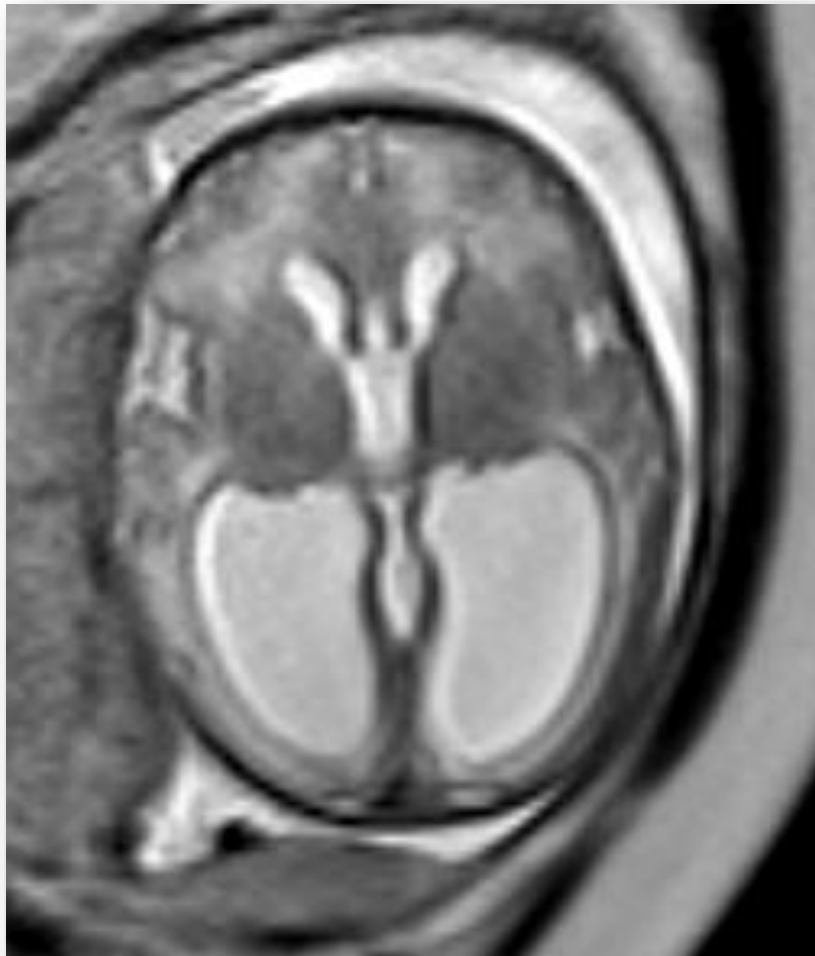


**Cavitazione**



**Inspessimento**





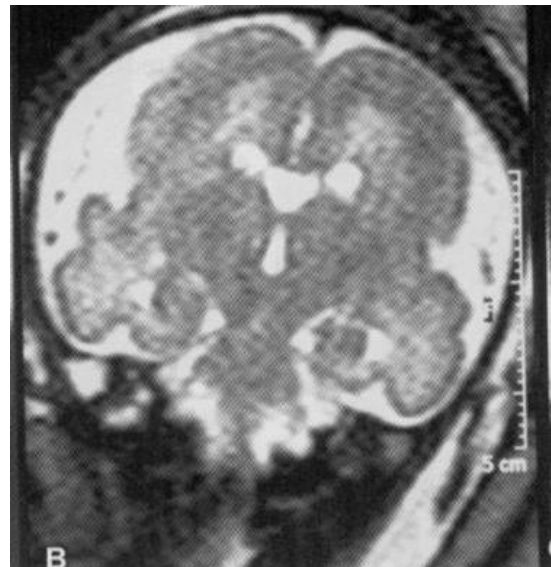
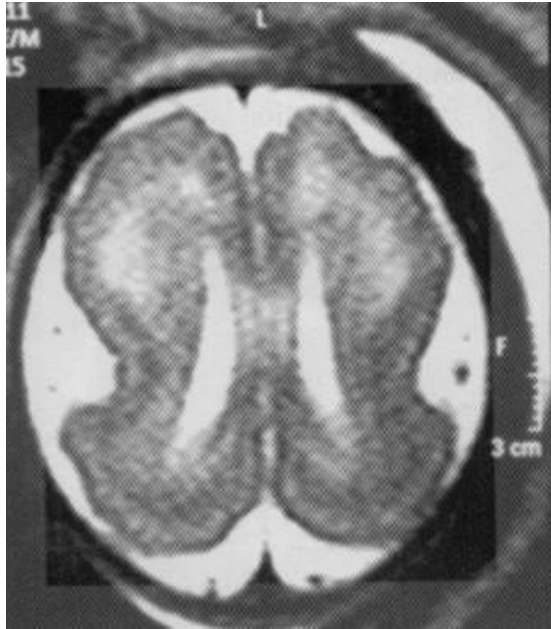
## Additional value of fetal magnetic resonance imaging in the prenatal diagnosis of central nervous system anomalies: a systematic review of the literature

A. C. ROSSI\* and F. PREFUMO†

\*Department of Obstetrics and Gynaecology, University of Bari, Bari, Italy; †Maternal-Fetal Medicine Unit, Department of Obstetrics and Gynaecology, University of Brescia, Brescia, Italy

2014

**Additional informations : 10%**



# Added value of fetal MRI in fetuses with suspected brain abnormalities on neurosonography: a systematic review and meta-analysis

Martine van Doorn<sup>1</sup>, Katrien Oude Rengerink<sup>2</sup>, Esther A Newsum<sup>3</sup>, Liesbeth Reneman<sup>1</sup>, Charles B Majoie<sup>1</sup>, Eva Pajkrt<sup>2</sup>

Affiliations + expand

PMID: 26592136 DOI: [10.3109/14767058.2015.1109621](https://doi.org/10.3109/14767058.2015.1109621)

## Abstract

**Purpose:** To evaluate the additional diagnostic value of fetal Magnetic Resonance Imaging (MRI) in fetuses with suspected brain abnormalities identified with advanced neurosonography (NS).

**Methods:** A systematic literature search was performed for studies reporting on a comparison between diagnosis with NS and MRI, in fetuses suspected for brain abnormalities. Abnormalities detected on NS were compared with those detected on MRI as well as with postnatal imaging findings to assess the added value of fetal MRI.

**Results:** We included 27 articles, reporting on 1184 cases in which NS and MRI diagnosis were compared. In 65% of cases [773/1184] fetal NS and fetal MRI diagnosis agreed completely. In 23% [312/1184], MRI showed additional or different pathology. In 8% [99/1184], MRI rejected the NS diagnosis with normal brain as conclusion. For 454 cases a comparison with postnatal imaging could be made. Compared to the postnatal diagnosis, fetal MRI diagnosis agreed completely in 80% [364/454] and fetal NS in 54% [243/454] (difference 27%, 95% CI 21-33%). Additional abnormalities were found on postnatal imaging in 36% [164/454] after NS and in 14% [61/454] after fetal MRI.

**Table 1** Variables related to presence *vs* absence of clinically relevant information on magnetic resonance imaging only (CRIMR) in series of 20 studies selected from the literature and our cohort

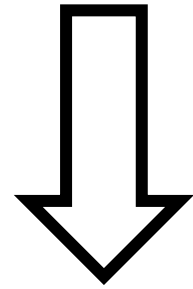
<i>Variable</i>	<i>CRIMR (n (%))</i>		<i>P</i>	<i>LR</i>
	<i>Yes</i>	<i>No</i>		
Specialty of first author			0.002	9.5
Fetal medicine/ obstetrics	46 (5.7)	757 (94.3)		
Radiology/ neuroradiology	72 (9.9)	652 (90.1)		
Ultrasound approach			< 0.001	26.4
Transvaginal	5 (1.6)	299 (98.4)		
Transabdominal	113 (9.2)	1110 (90.8)		

LR, likelihood ratio.

Paladini 2019

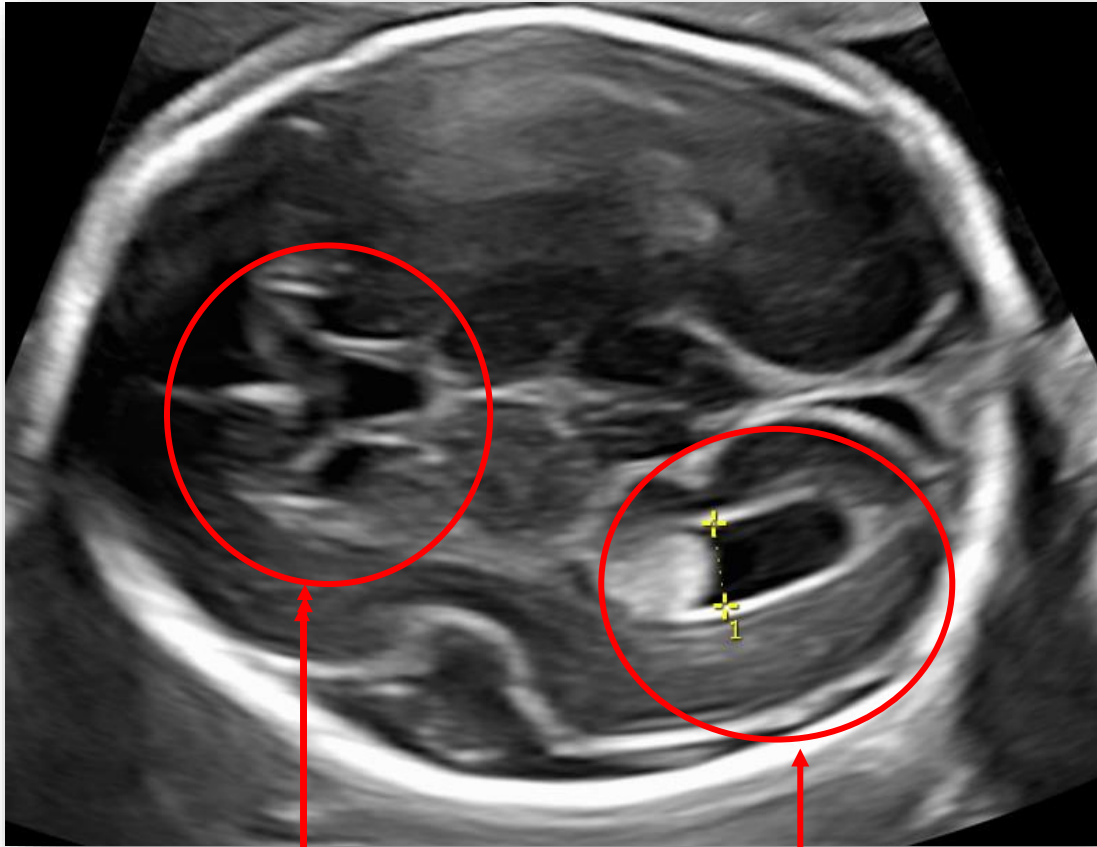
- Eseguire una accurata neurosonografia prima di richiedere una RM
- RM effettuata da Neuroradiologo dedicato

dal segno (screening)



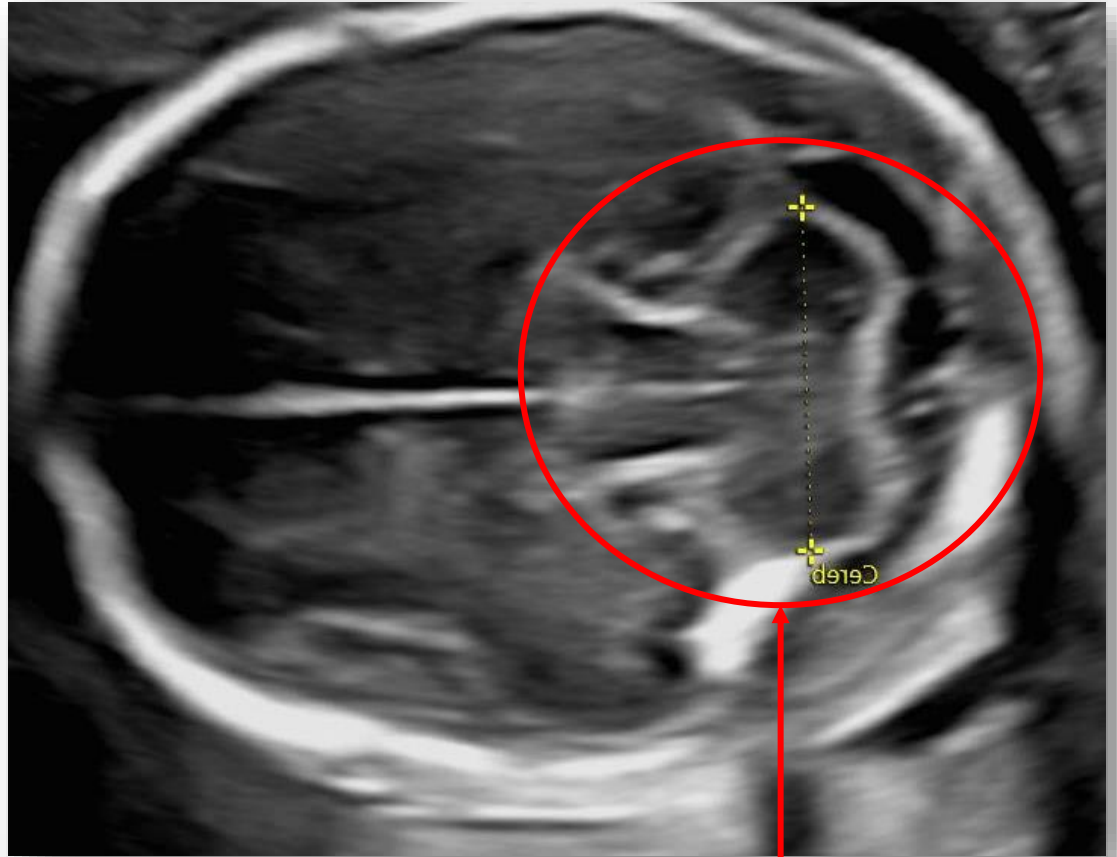
alla diagnosi (neurosonografia)





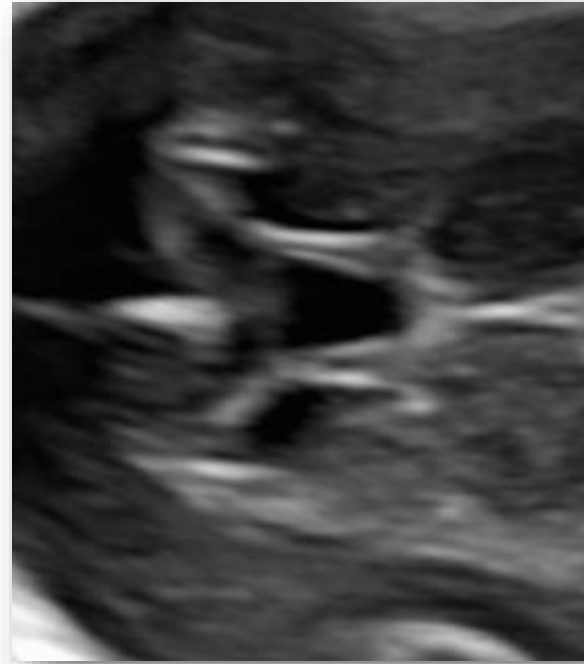
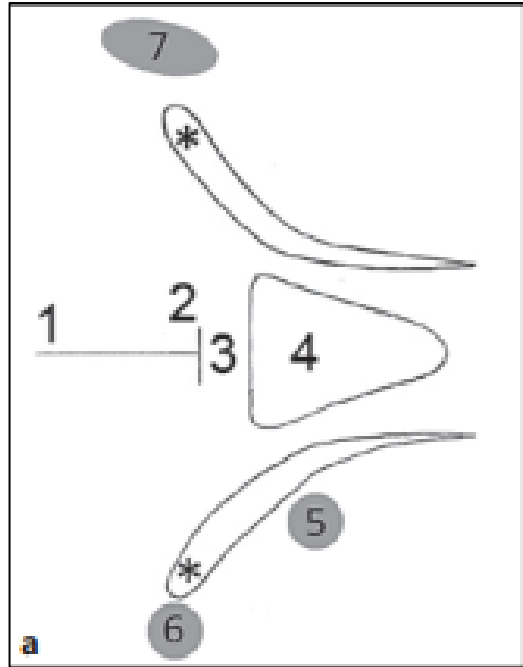
**CSP**

**Atrio**

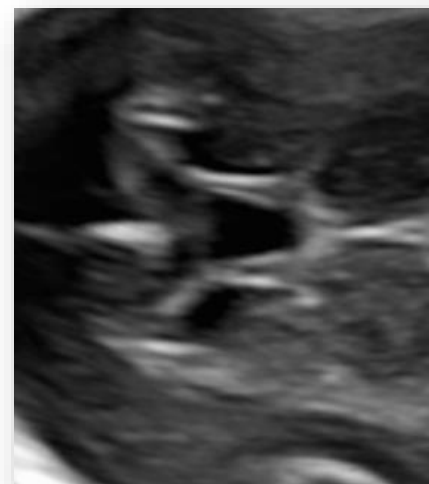
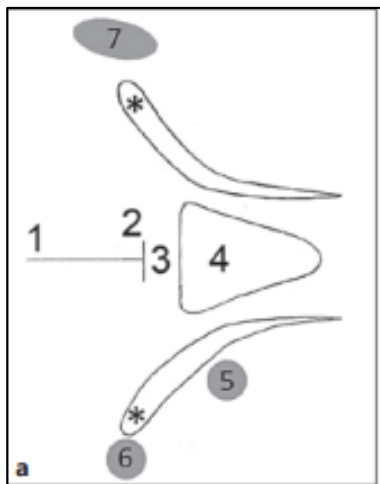


**FCP**

# Complesso anteriore



- 1 Scissura interemisferica
- 2 Solco calloso
- 3 Ginocchio del corpo calloso
- 4 Cavo del setto pellucido
- 5 Matrice germinativa
- 6 Angolo esterno del ventricolo laterale
- 7 Sostanza bianca periventricolare
- \* Corni frontali dei ventricoli laterali



**Mancata visualizzazione del CSP**

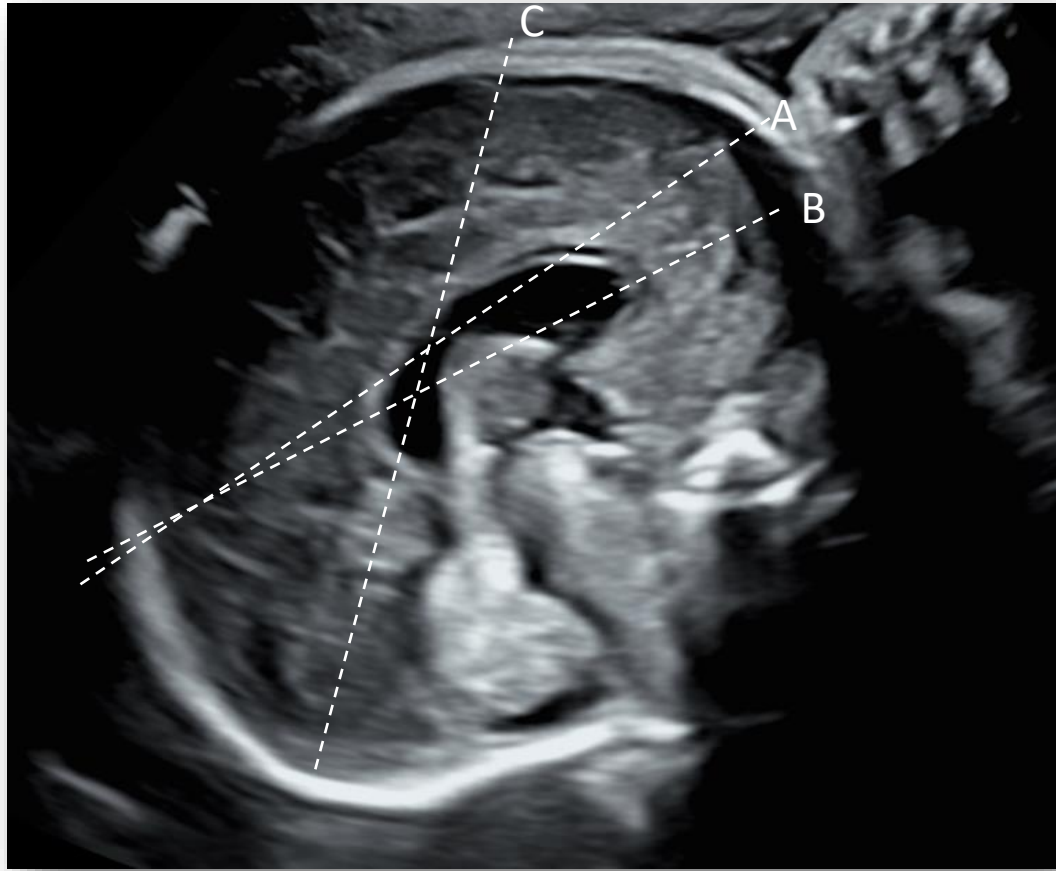
**Agenesia completa del CC**



A

B

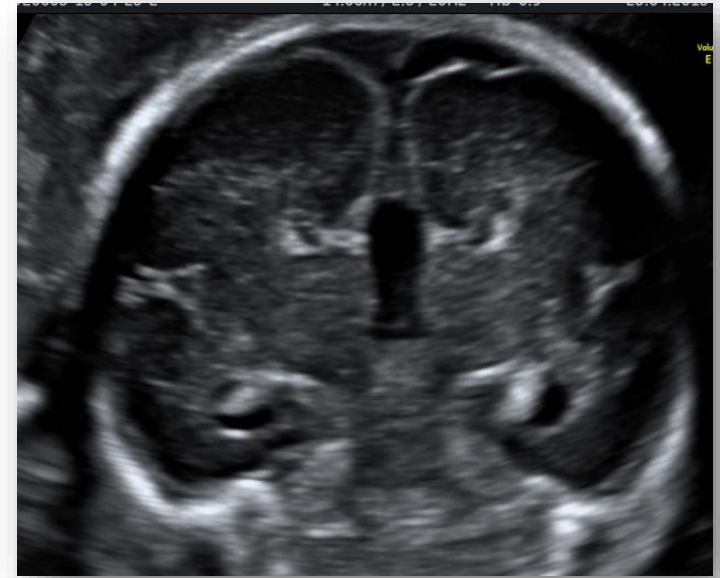
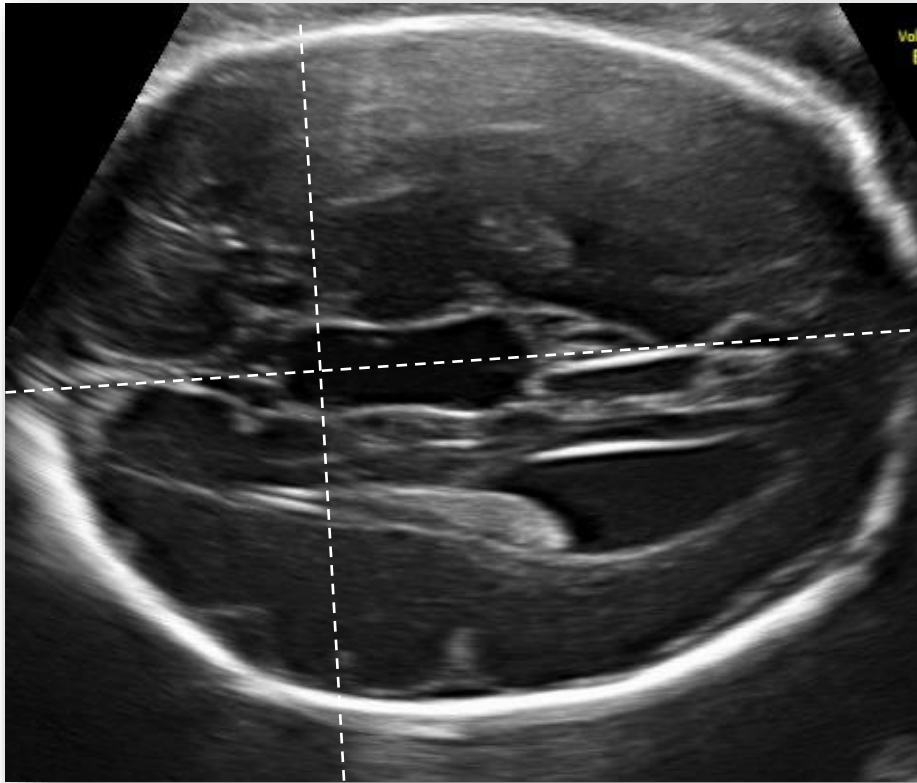
C

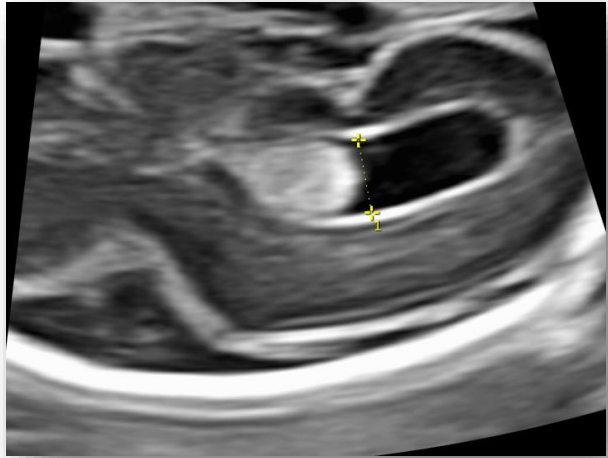




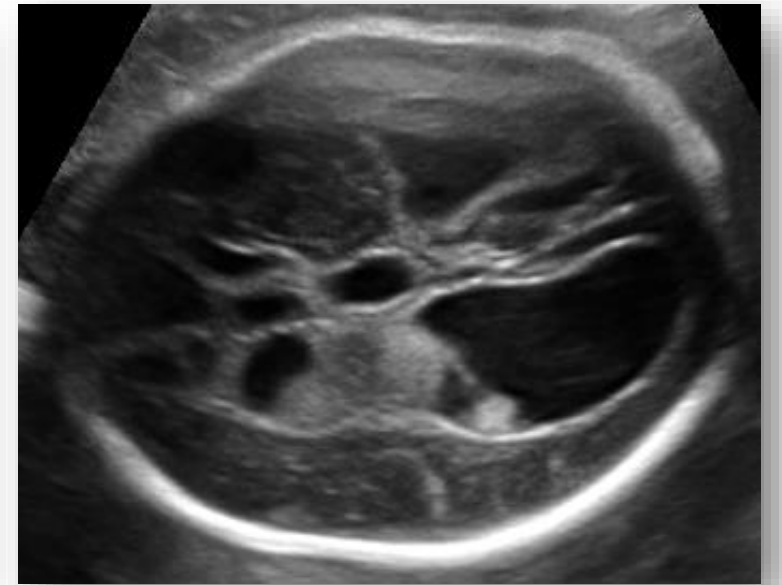
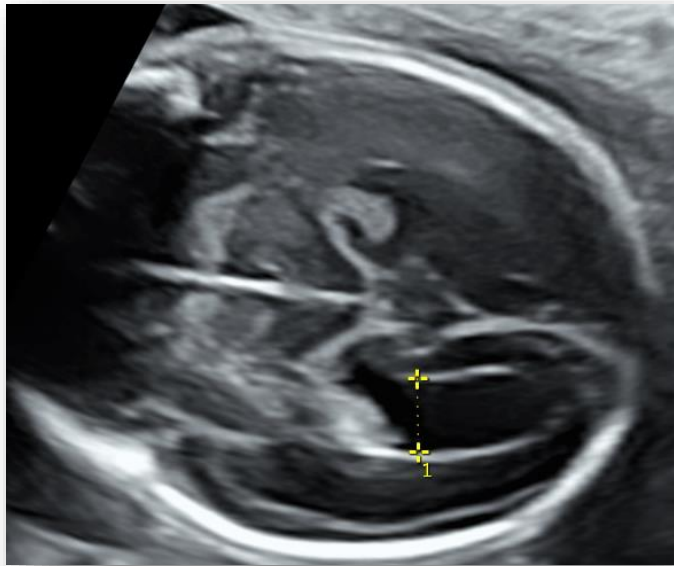
Agenesia completa del CC con  
dilatazione cistica del 3° ventricolo

CSP/CV ampio?





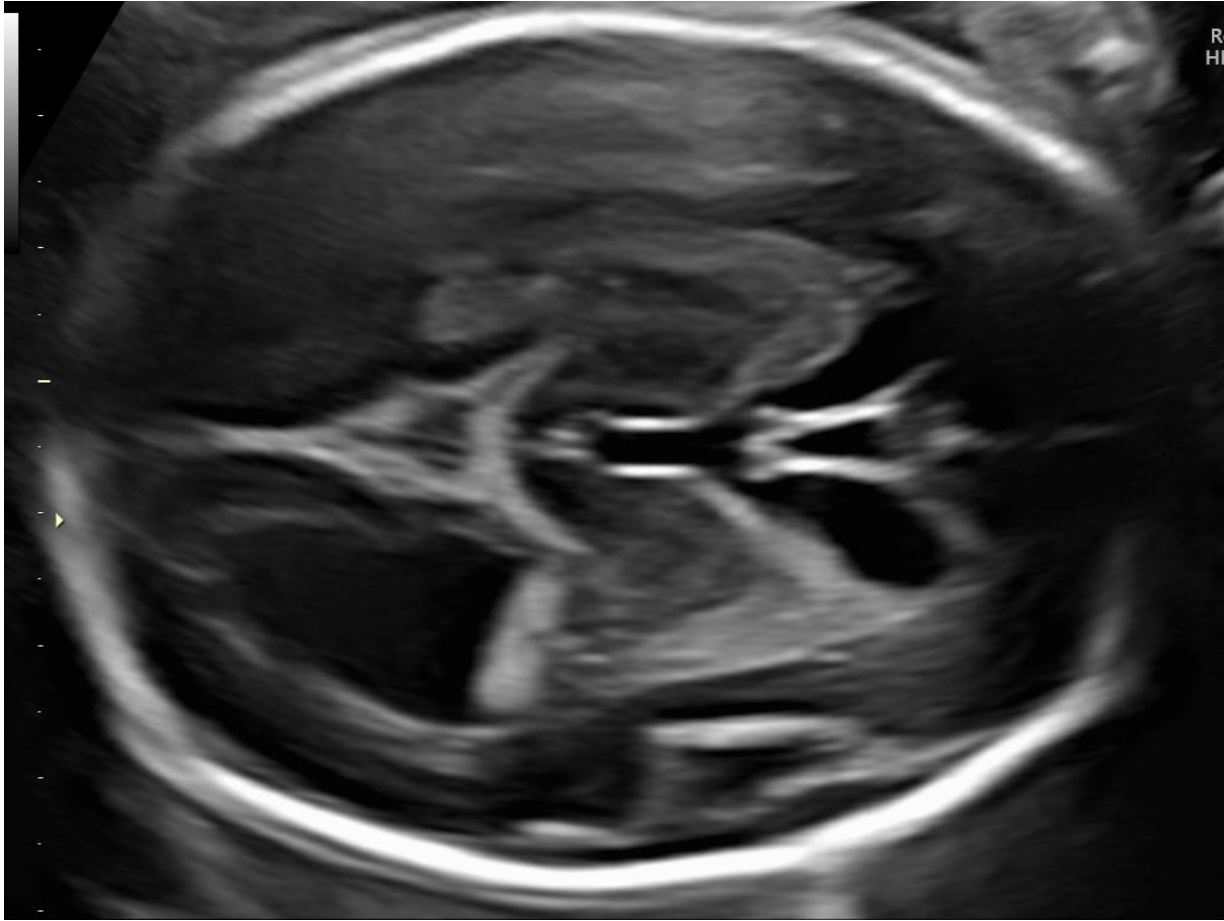
# Ventriculomegalia



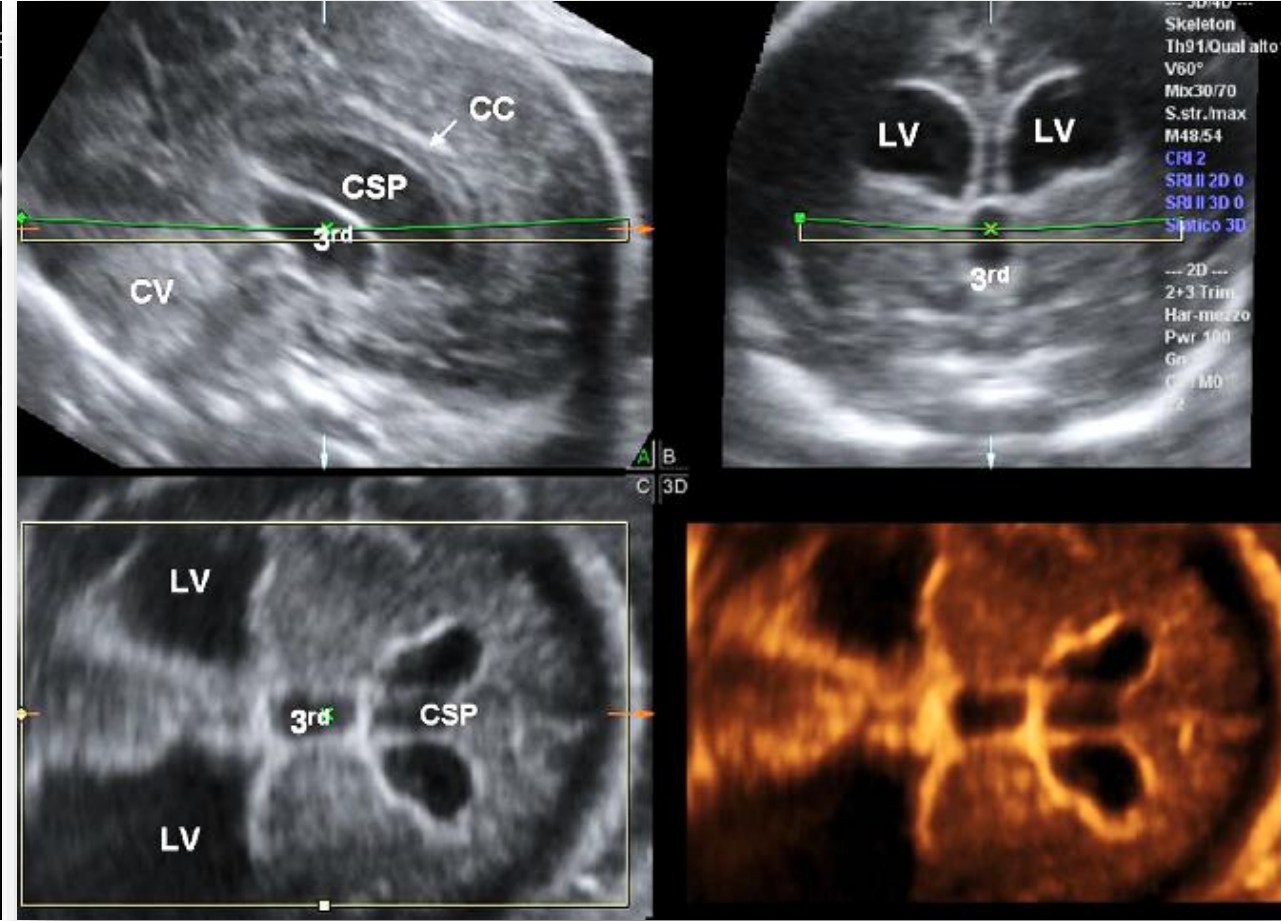
Lieve  
Severa

Moderata

# Ventricolomegalia severa

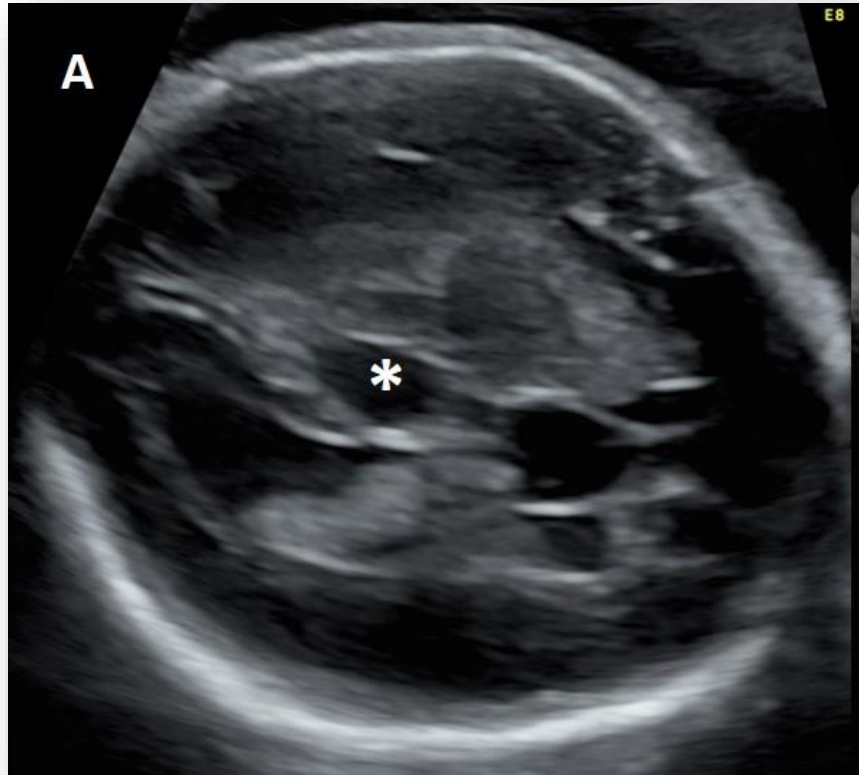


# Stenosi dell'acquedotto

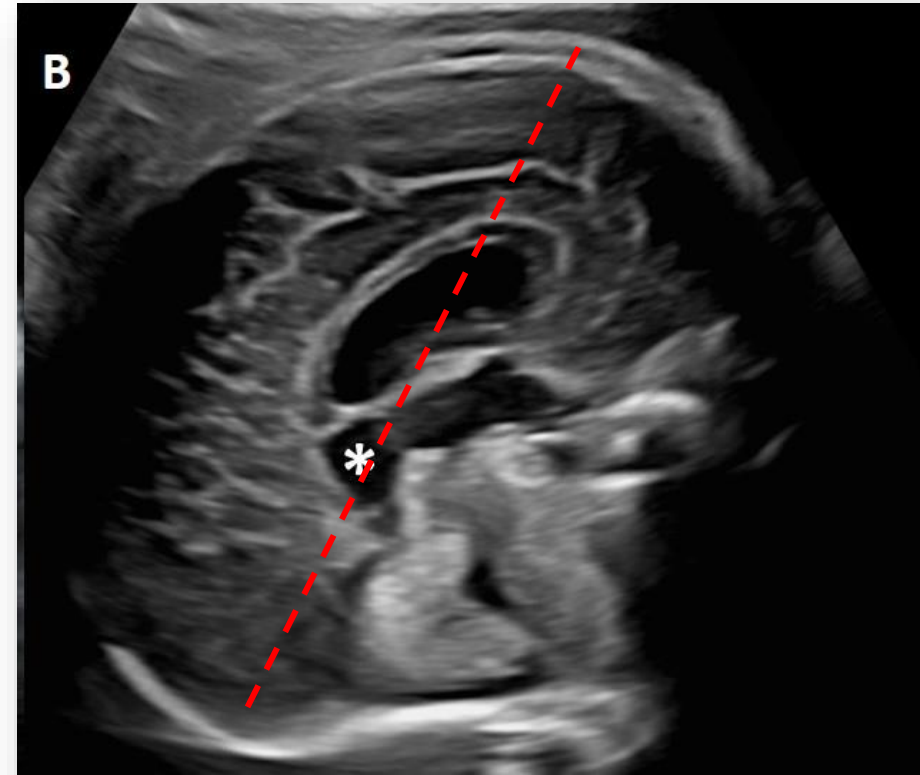




**Cisti interemisferica**  
**Ventricolomegalia lieve**



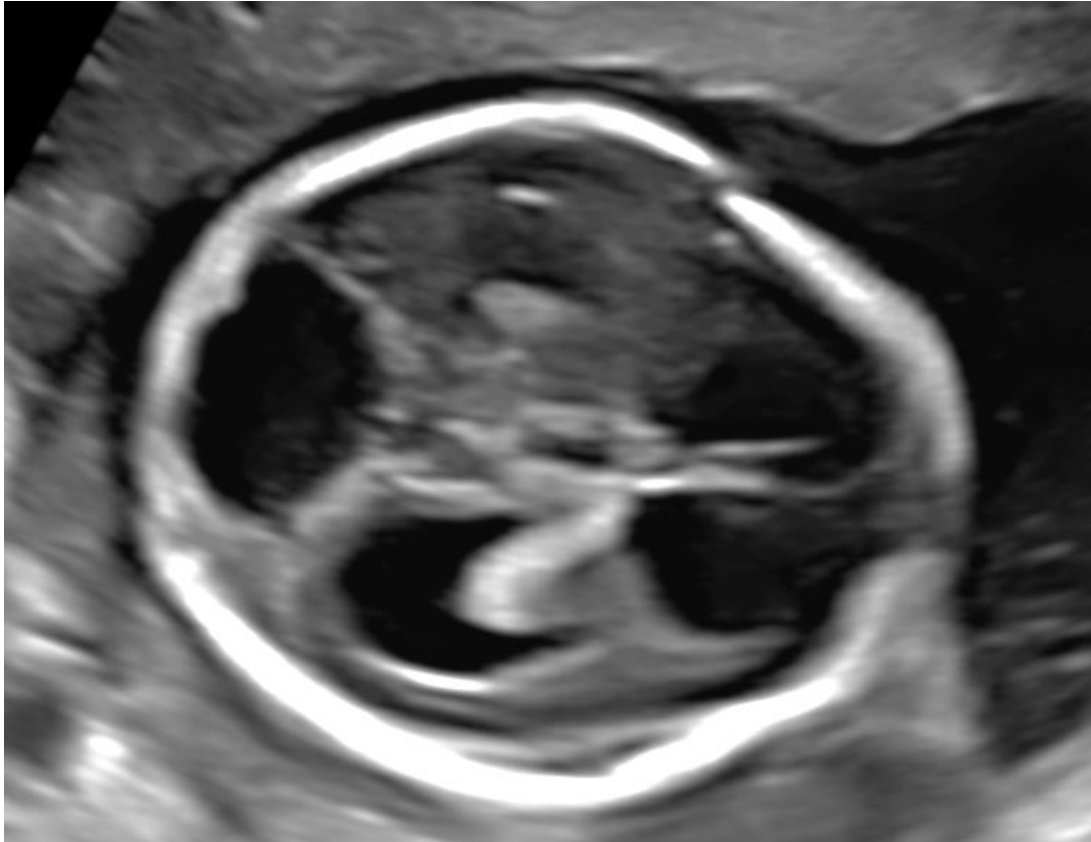
**Dilatazione recesso sovrapineale**





**Ventricolomegalia e cisti in FCP**

**DW +ACC**



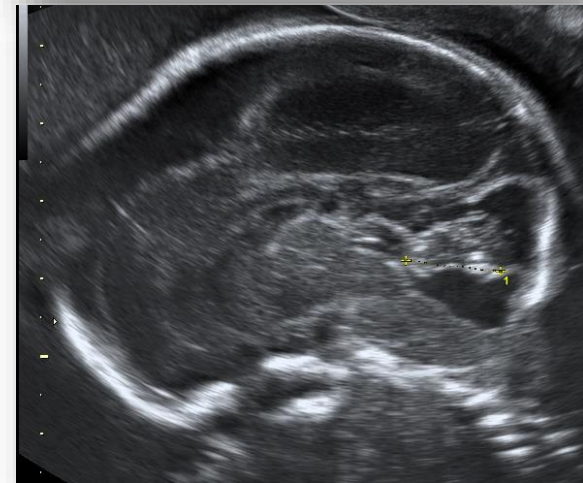
# Cisti in FCP



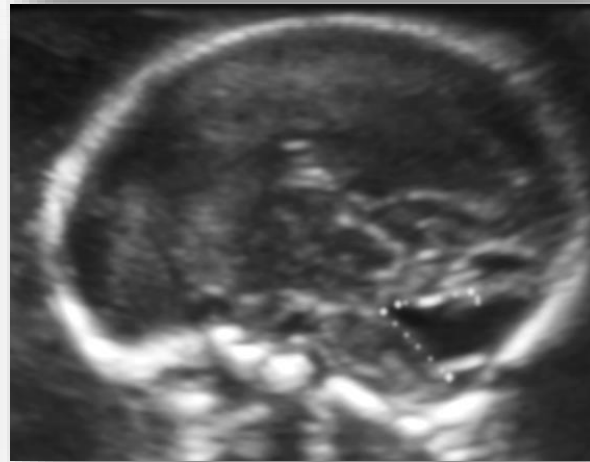
- Cisti di Blake
- Ipoplasia vermiana
- M. di Dandy Walker



- Dimensioni e morfologia del verme cerebellare
- Grado di rotazione del verme cerebellare
- Inserzione del tentorio



**Cisti di Blake  
Walker**



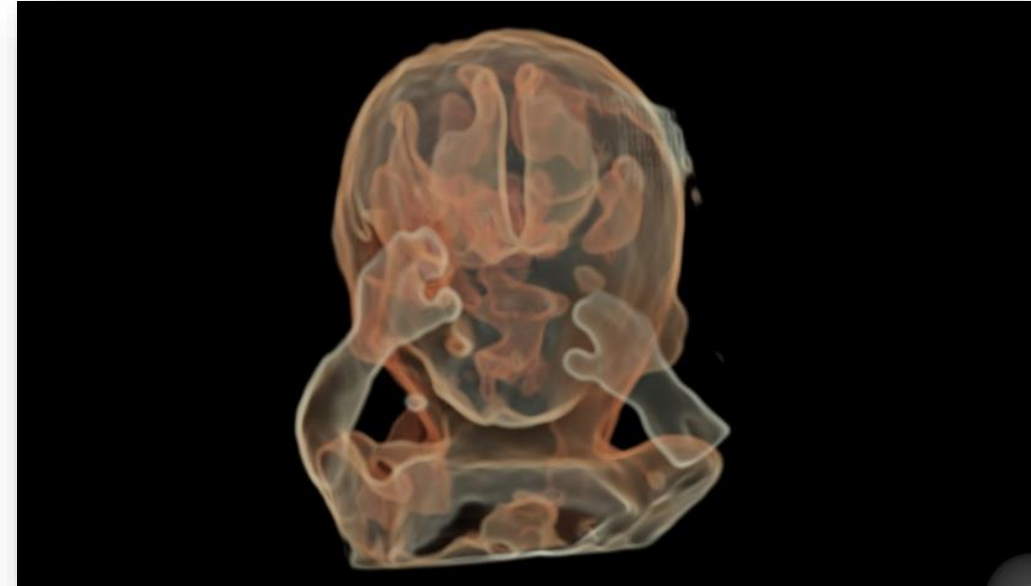
**Ipoplasia vermiana**



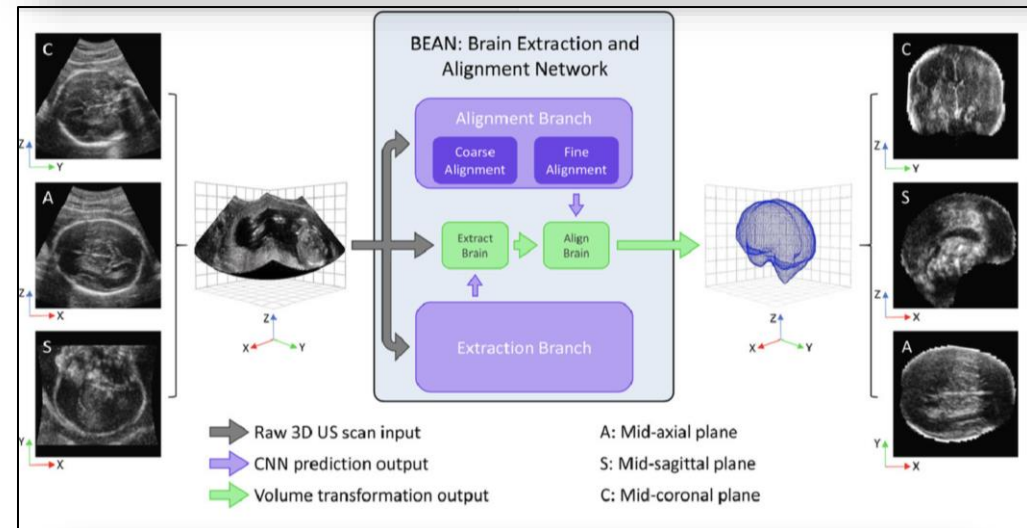
**Dandy-**

# Neurosonologia fetale: prospettive

- Diagnosi più precoci grazie alle nuove tecnologie

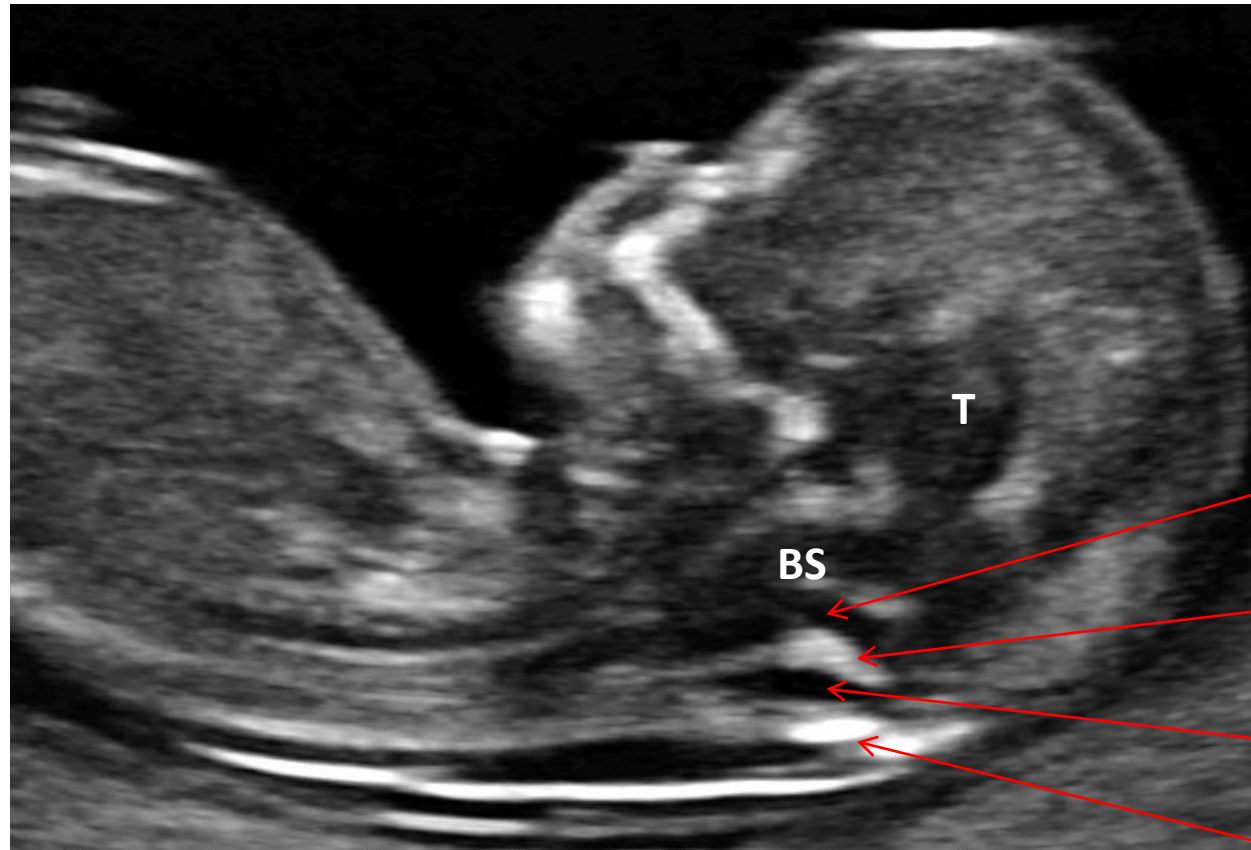


- Diagnosi "automatiche" grazie alla intelligenza artificiale





# Encefalo in scansione sagittale durante l'esame di 11-13+4 settimane



4° ventricolo (IT)

Plesso corioideo del 4° ventricolo

Cisterna magna

Osso occipitale

# Anomalie FCP nel 1° trimestre



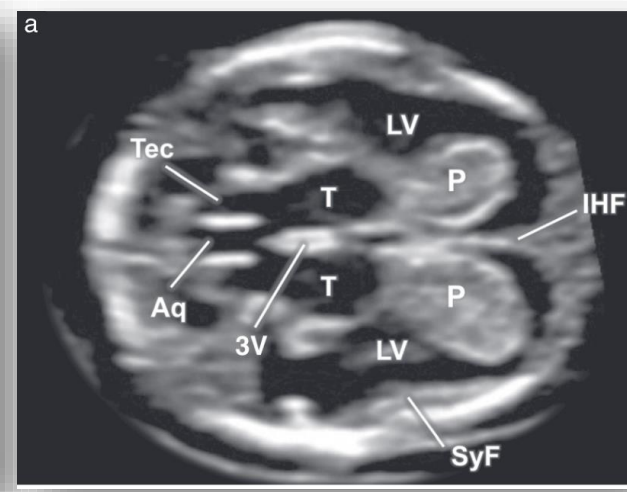
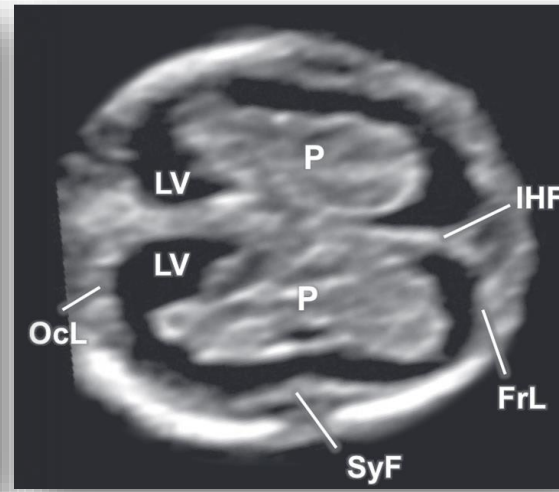
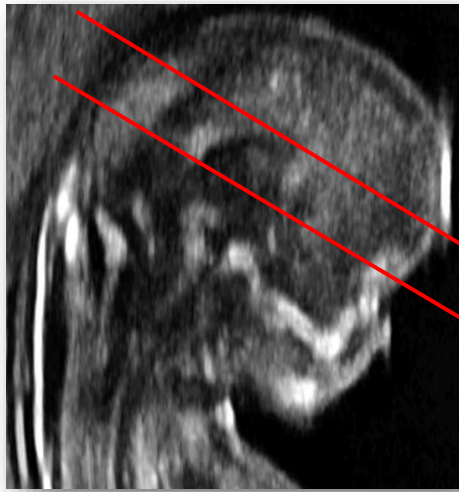
Spina bifida



Normale



Patologia cistica



*Ultrasound Obstet Gynecol* 2021; 57: 204–214  
 Published online in Wiley Online Library (wileyonlinelibrary.com).

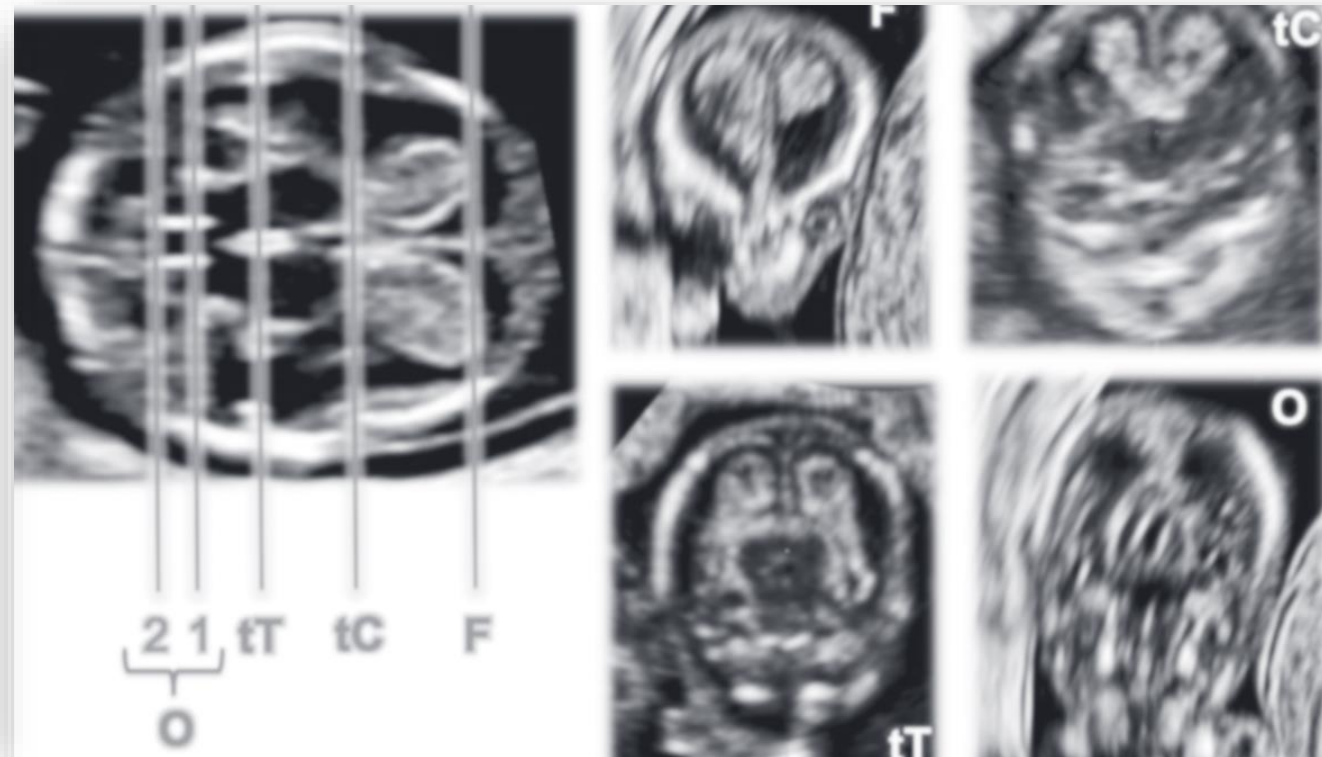
## State-of-the-Art Review

### First-trimester fetal neurosonography: technique and diagnostic potential

N. VOLPE<sup>1</sup>, A. DALL'ASTA<sup>1</sup>,  
 E. DI PASQUO<sup>1</sup>, T. FRUSCA and T. GHI\*<sup>1</sup>

*Department of Medicine and Surgery, Unit of Surgical Sciences,  
 Obstetrics and Gynecology, University of Parma, Parma, Italy*

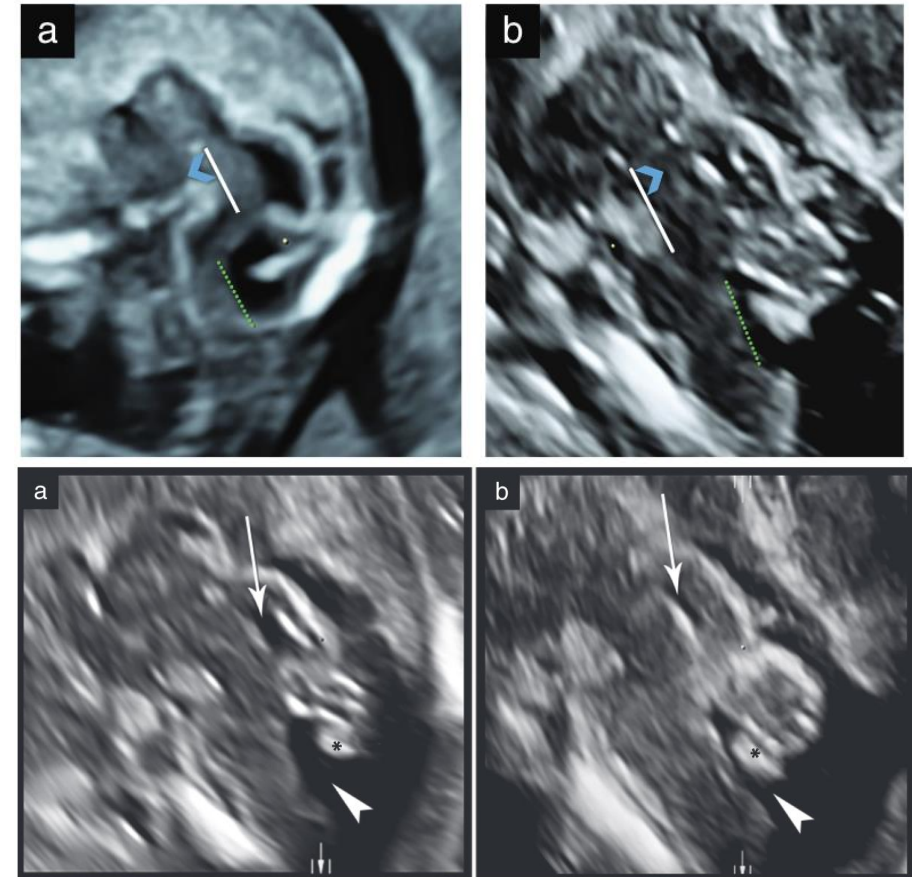
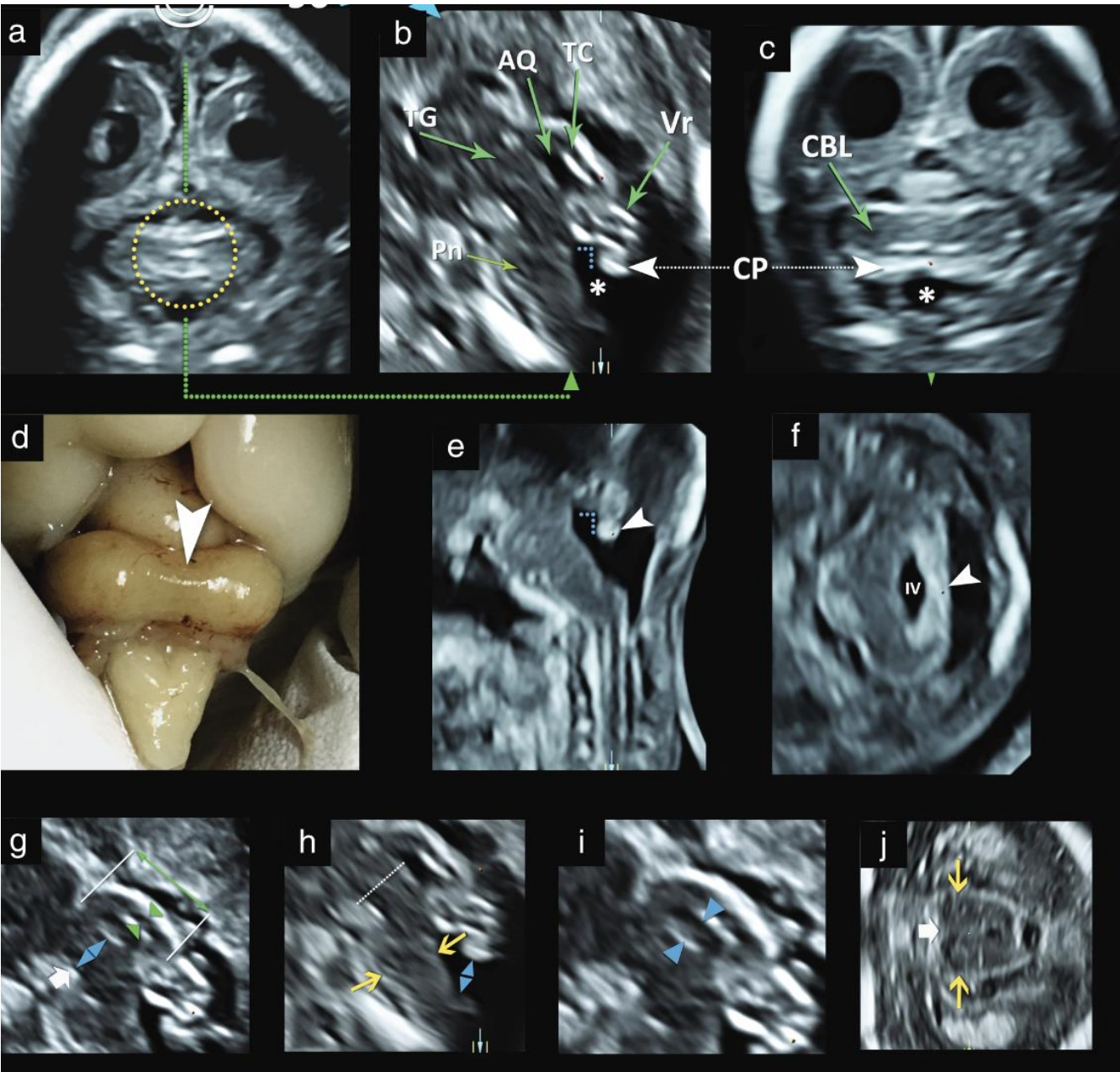
\*Correspondence. (e-mail: tullioghi@yahoo.com)





## Early second-trimester three-dimensional transvaginal neurosonography of fetal midbrain and hindbrain: normative data and technical aspects

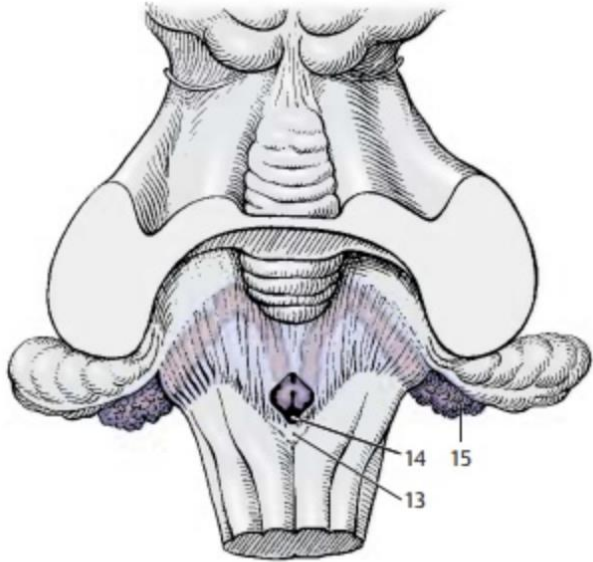
R. BIRNBAUM<sup>1,2</sup> , R. BARZILAY<sup>3</sup>, M. BRUSILOV<sup>1,2</sup>, P. ACHARYA<sup>4</sup>, G. MALINGER<sup>1,2</sup>   
and K. KRAJDEN HARATZ<sup>1,2</sup>



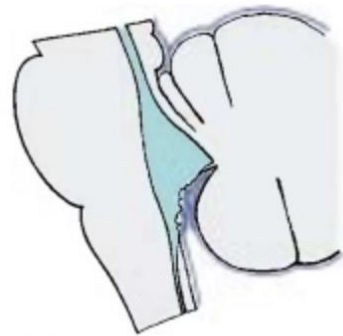


# Position of the choroid plexus of the fourth ventricle in first- and second-trimester fetuses: a novel approach to early diagnosis of cystic posterior fossa anomalies

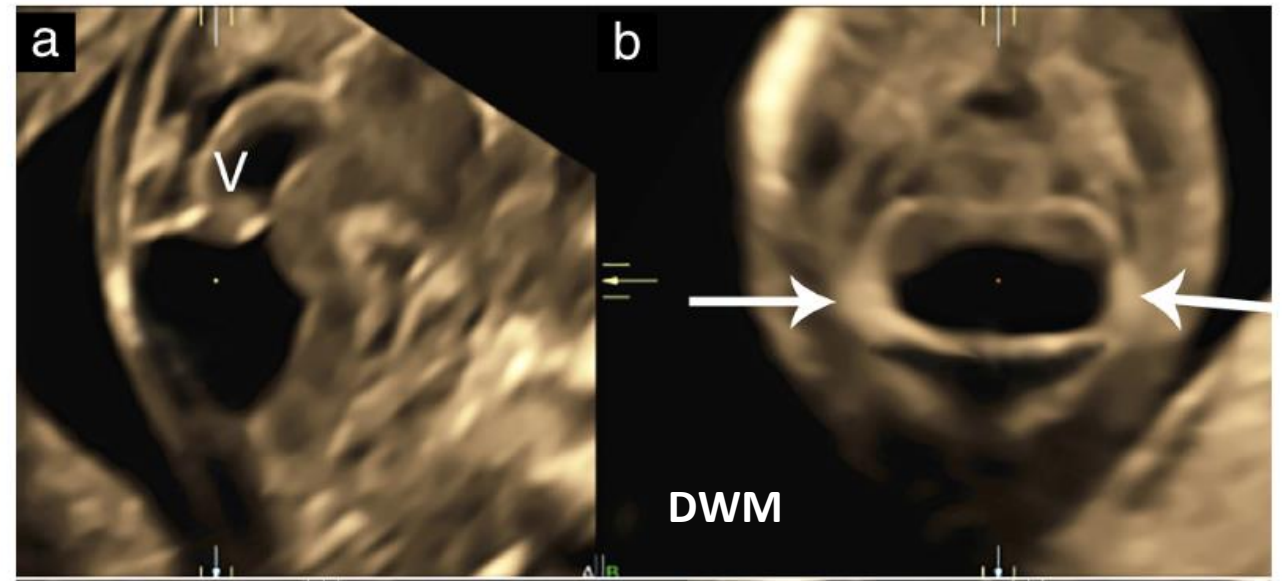
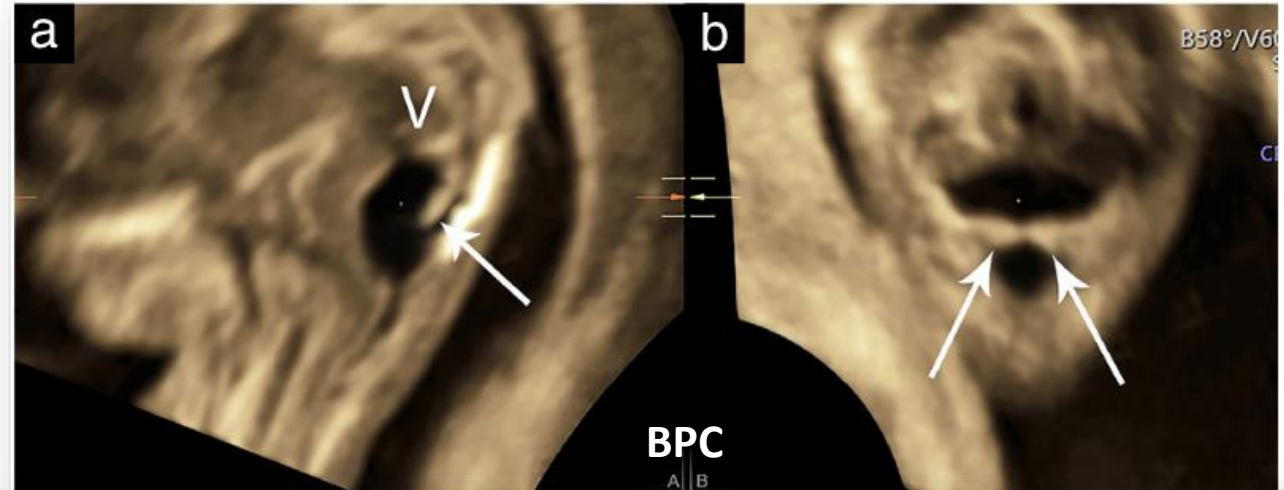
P. VOLPE<sup>1</sup>, V. DE ROBERTIS<sup>1</sup>, G. VOLPE<sup>2</sup>, S. BOITO<sup>3</sup>, T. FANELLI<sup>1</sup>, C. OLIVIERI<sup>1</sup>, C. VOTINO<sup>1</sup> and N. PERSICO<sup>3,4</sup> 2021



D Plexus of the fourth ventricle, view from above

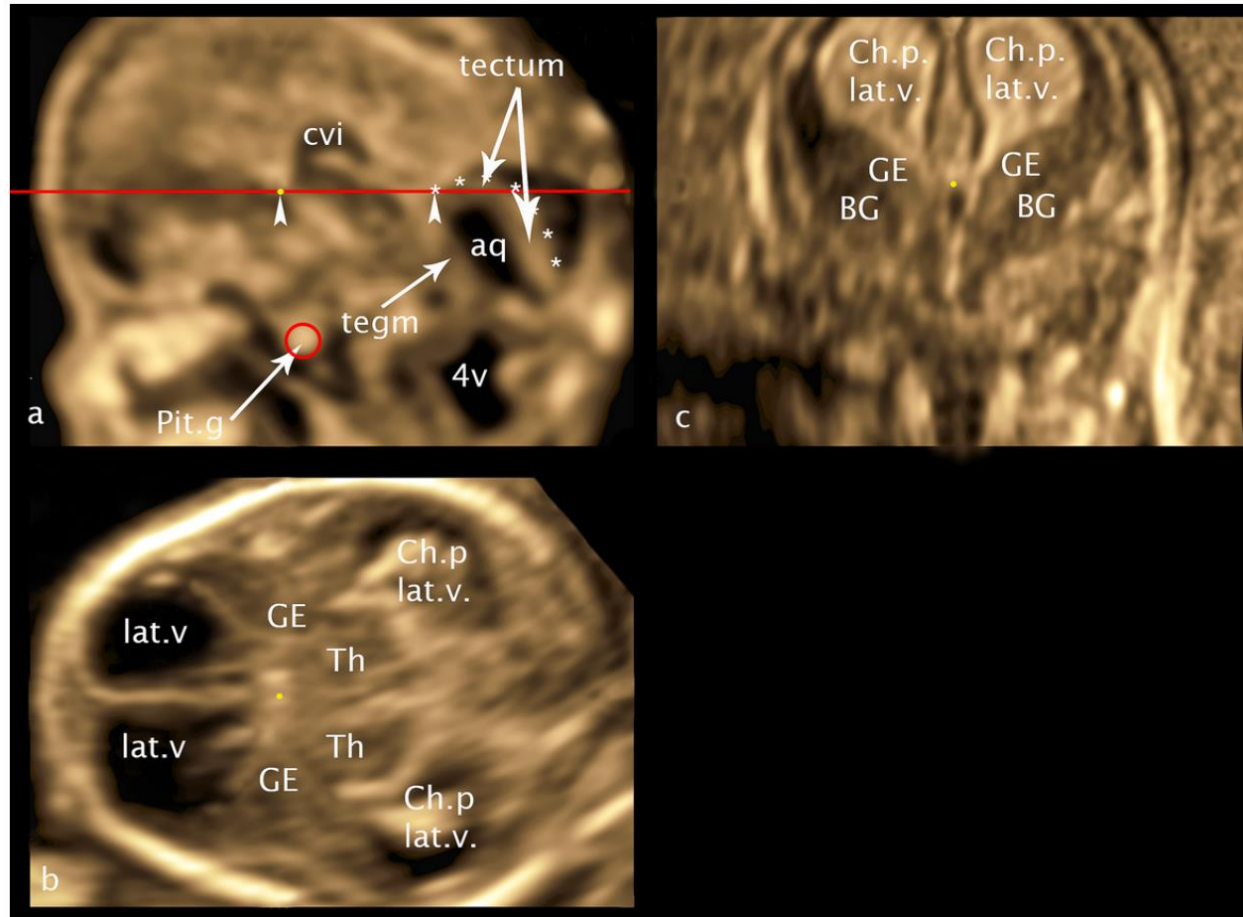


E Plexus of the fourth ventricle, lateral view

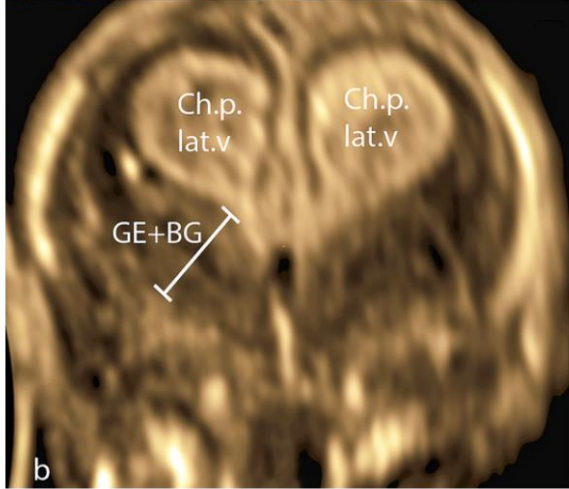
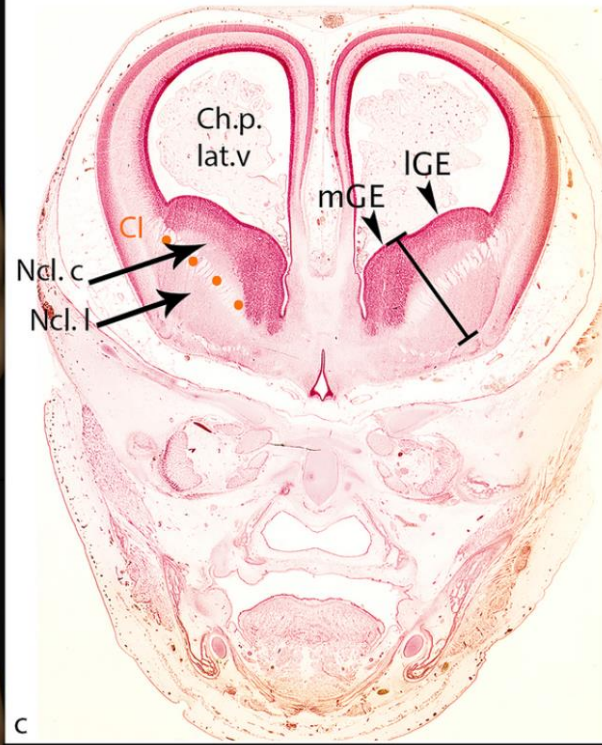
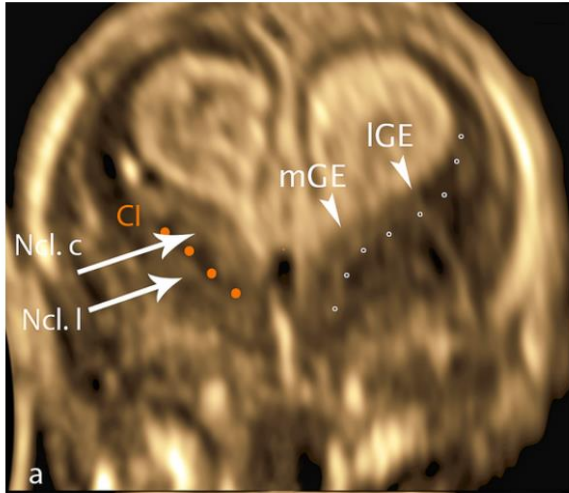


# Development of the Prosencephalic Structures, Ganglionic Eminence, Basal Ganglia and Thalamus at 11+3 to 13+6 Gestational Weeks on 3D Transvaginal Ultrasound Including Normative Data

Reinhard Altmann (✉ [reinhard.altmann@me.com](mailto:reinhard.altmann@me.com))  
Kepler Universitätsklinikum

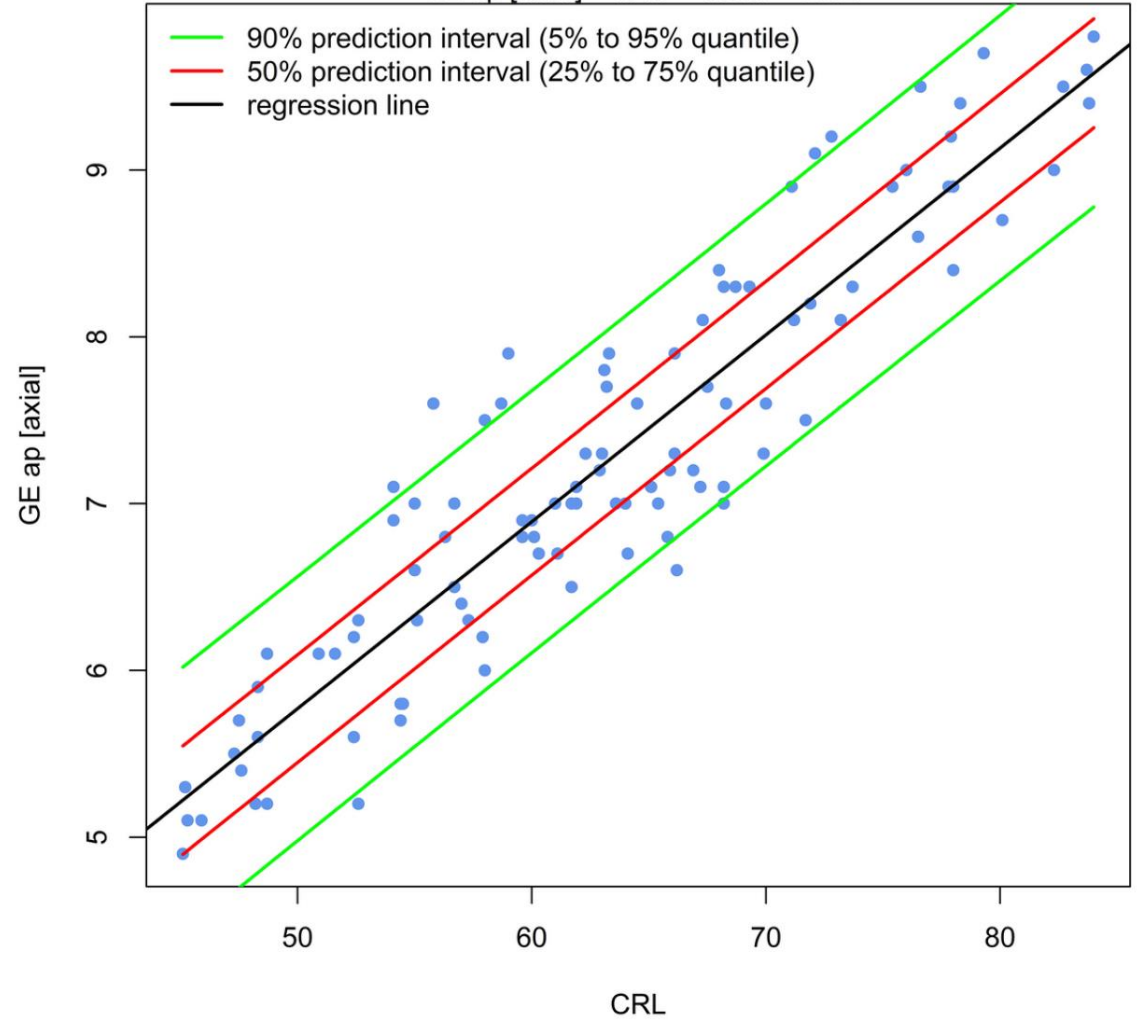






### Scatter Plot with Prediction Interval

$$GE\ ap\ [axial] = 0.17 + 0.112 * CRL$$



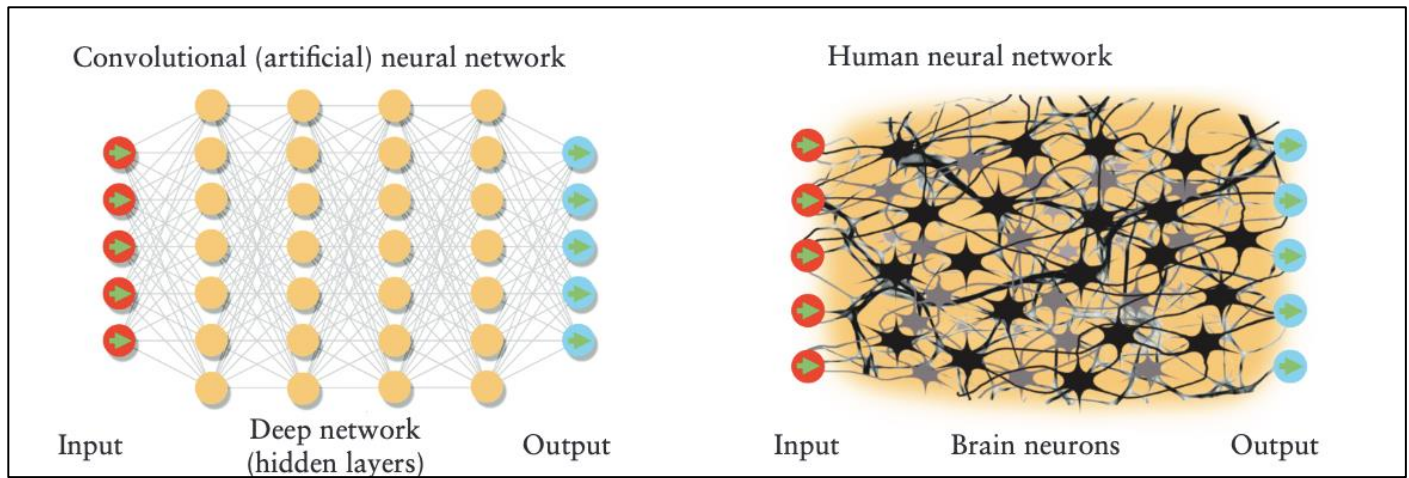
# Introduction to artificial intelligence in ultrasound imaging in obstetrics and gynecology

L. DRUKKER<sup>1</sup> , J. A. NOBLE<sup>2</sup>  
and A. T. PAPAGEORGHIOU<sup>1\*</sup>

<sup>1</sup>Nuffield Department of Women's & Reproductive Health, University of Oxford, John Radcliffe Hospital, Oxford, UK;

<sup>2</sup>Institute of Biomedical Engineering, University of Oxford, Oxford, UK

\*Correspondence. (e-mail: aris.papageorghiou@wrh.ox.ac.uk)

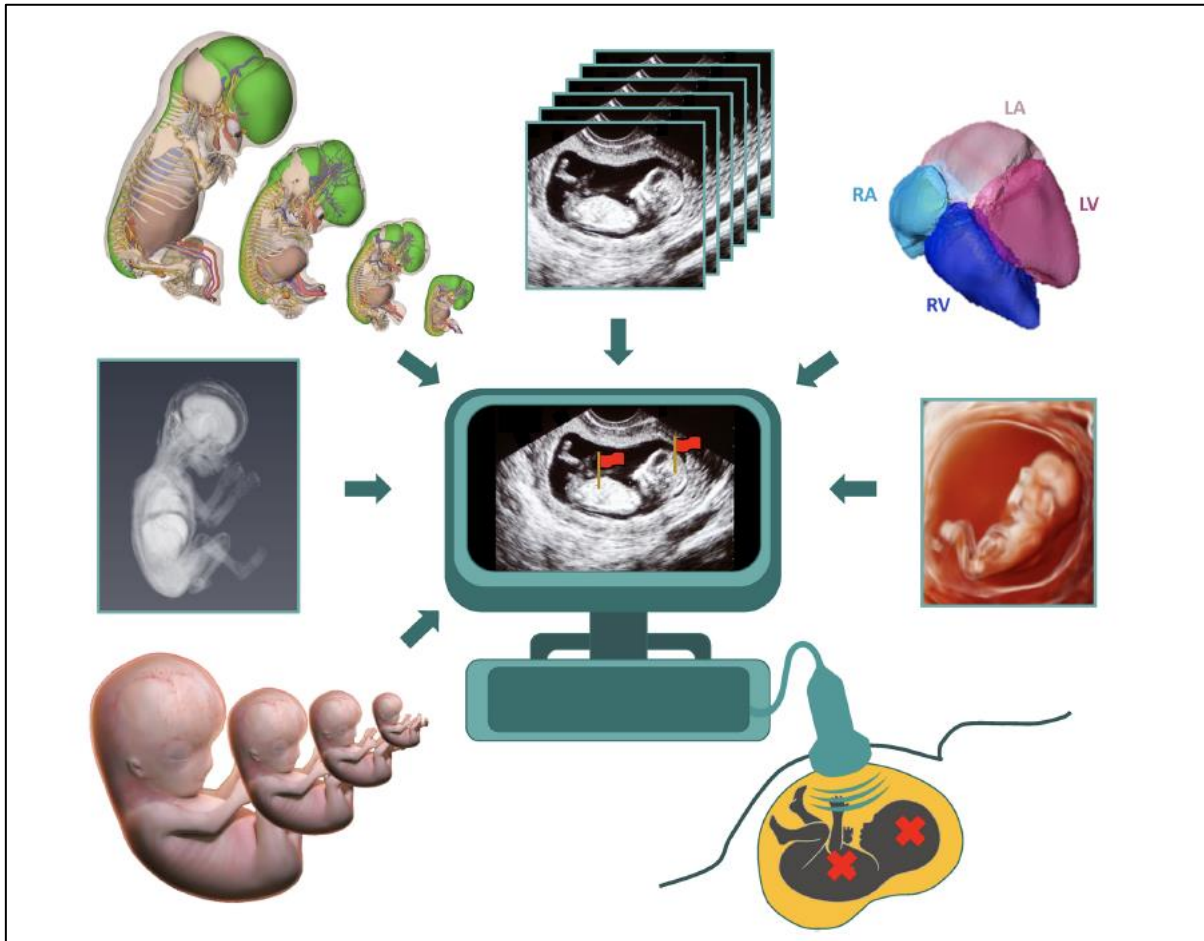


**Table 1** Examples of reported and expected future artificial intelligence (AI) applications in obstetric and gynecological ultrasound

<i>AI application</i>	<i>Description</i>	<i>Clinical utility</i>
Probe guidance	Operator is guided how to manipulate probe to acquire fetal biometric plane	Facilitate sonographer training; basic scanning can be performed by non-expert (e.g. general practitioner)
Fetal biometric plane finder	Standard fetal biometric planes are automatically acquired, measured and stored	Reduce repetitive caliper adjustment clicks; reduce operator bias; instant quality control
Anomaly scan completeness	Anomaly scan checklist of mandatory planes is populated automatically	Ensure completeness of imaging and that all parts of anatomy are checked
Anomaly highlighting	Unusual fetal findings are identified in a standard plane	Highlight suspected abnormal finding; assist sonographer with referral decision



# Applicazione della I.A. all'ecografia fetale

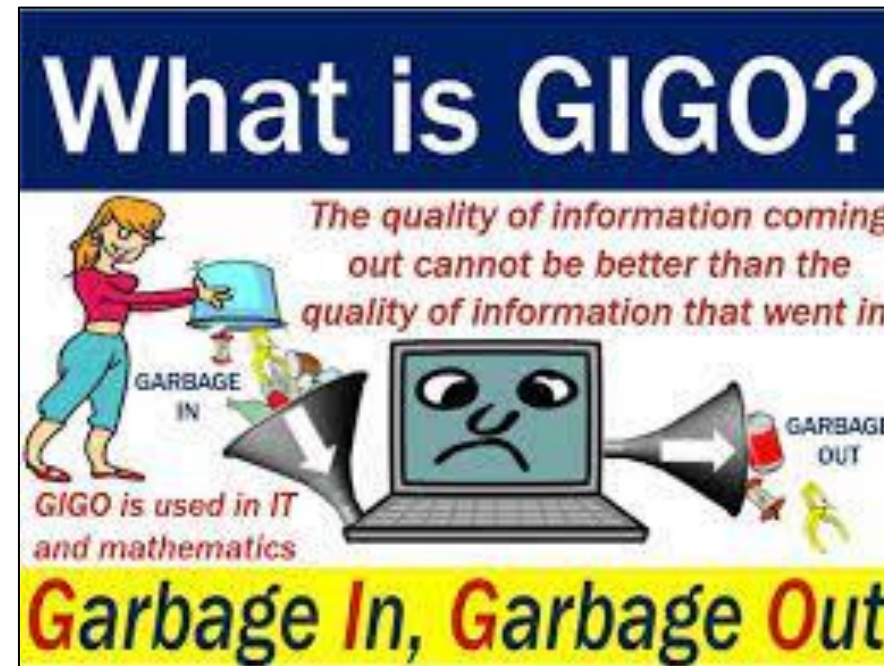


- L'ecografo viene "istruito" attraverso l'inserimento di multipli dati 2D e 3D su quella che è l'anatomia ecografica normale del feto in via di sviluppo
- Quando viene rilevata una deviazione dalla anatomia di default l'ecografo allerta l'operatore segnalando la sede del problema
- In questa maniera cala il numero dei falsi negativi

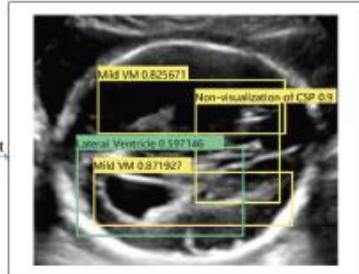
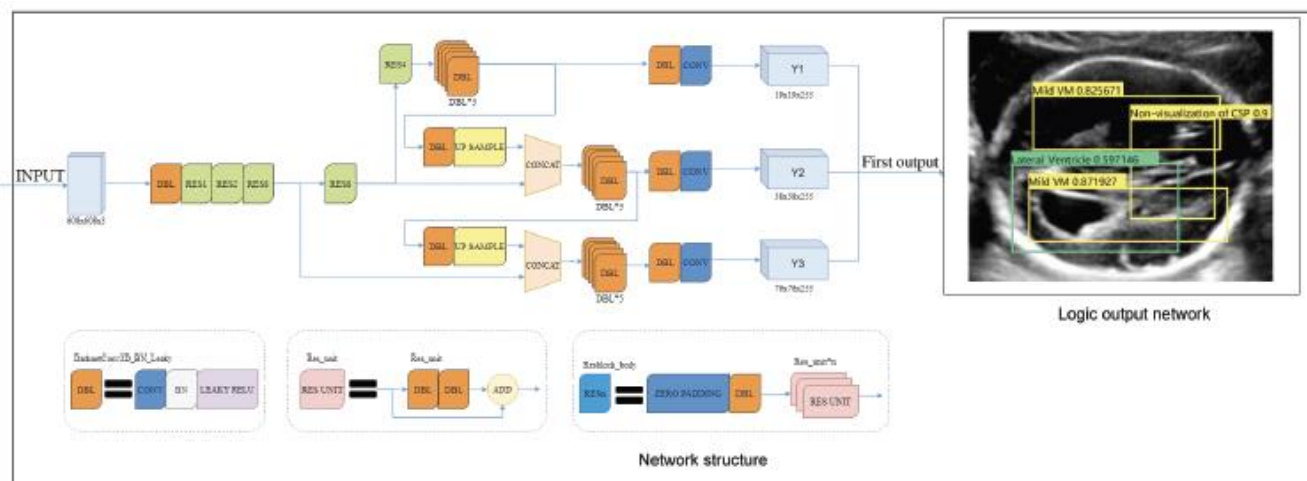


## Use of real-time artificial intelligence in detection of abnormal image patterns in standard sonographic reference planes in screening for fetal intracranial malformations

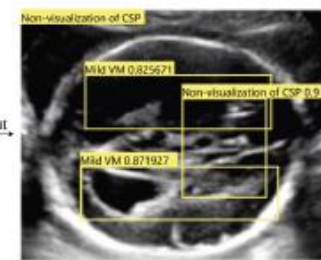
M. LIN<sup>1#</sup>, X. HE<sup>2#</sup>, H. GUO<sup>3#</sup>, M. HE<sup>1</sup>, L. ZHANG<sup>1</sup>, J. XIAN<sup>4</sup>, T. LEI<sup>1</sup>, Q. XU<sup>3</sup>, J. ZHENG<sup>1</sup>, J. FENG<sup>1</sup>, C. HAO<sup>5</sup>, Y. YANG<sup>1</sup>, N. WANG<sup>6</sup> and H. XIE<sup>1</sup>



Input image



Logic output network



Output image

**GRAZIE**