When to use US & when to use MRI: Is there a literature bias?

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Learning Objectives:
• I hope that after this lecture we, as a group, should be able to
  – summarize the advantages and limitations of Ultrasound and MRI in imaging the fetal CNS
  – critically evaluate the published literature about the use of US and MRI
  – appropriately prepare and counsel patients regarding the best choice of imaging modality, and
  – modify utilization of our dwindling resources.

I often challenge the practice of referring patients first to CT/MRI before:
• ...realizing that Ultrasound (US) could solve the problem faster, cheaper and at times better;
• ...understanding the fundamental differences between the different imaging modalities;
• ...inquiring who reads the US and the MRI, and what is his/her experience involving the issue;
• ...and when and if reading articles claiming biased superiority of one imaging method over the other (usually that of MRI) reading their Materials and Methods section

Here are some of the frequently asked clinical questions:

- Is it an accreta?
- Is it AGCC
- Is it cornual pregnancy?

Today I will discuss the use of US and MRI in evaluating the Fetal CNS
For decades closely following the pertinent literature and as needed contributing articles to place US and MRI in the correct light as far as my practice was, and is concerned.

Here are some my involvements in the above to support this:

The basis of my incentive conceiving this talk: I quote:

• “Much has been written recently about the relative merits and demerits of fetal imaging with US and MRI.
• Unfortunately, the arguments generate more heat than light.
• This is an attempt to identify the strengths and weaknesses of each modality from the literature, and to arrive at some practical recommendations on when to use which imaging modality”

FROM: Daniela Preyer. Obstetrics and and Gynecology, Surgery 2008 CME
I start with these statements made almost 10 years ago. They are valid even today.

• The use of fetal brain MRI is now widely accepted based on the assumption that provides additional information to US
• Its real contribution to the US dx of fetal brain anomaly is poorly evaluated
• Only few studies compare both neuromaging modalities performed by skilled operators. 

Daniela Prayer is recognized as the best and foremost fetal MRI expert in the world.

Starting Premises

1. Transabdominal and transvaginal US are (and should always be) the primary imaging modalities to assess the fetal CNS
2. MRI should always be a complementary imaging modality

Advantages of Transabdominal & Transvaginal brain scan

• They are safe
• Relatively inexpensive
• The use of 3D capability
• Ability to depict vessel anatomy & blood flow using color Doppler
• High spatial resolution with newer probes
• No special room required

(Relative) Limitations of Transabdominal Ultrasound

• Small field of view (good for detail)
• Limited acoustic contrast between soft-tissue structures (Newer vaginal probes may help)
• Beam attenuation by maternal adipose tissue (use TVS if vertex!)
• Poor acoustic access to fetal head deeply engaged in the maternal pelvis (use TVS!!)
• Poor image quality in oligohydramnios (try the fontanelles or TVS if vertex!)
• Limited visualization of posterior fossa due to calvarial calcification after 33 weeks
• Limited access in some cases of microcephaly

Advantages of Fetal MRI

• Technical: no bone shadowing
• Larger field of view
• Superior soft tissue contrast resolution
• Good imaging of both sides if the brain
• More precise volumetric measurements (able to see global findings)
• Good accuracy in demonstration of intracranial abnormalities (mainly after 24 weeks!)
• Lately: the development of new techniques
Limitations of Fetal neuro-MRI
- Even with multichannel and fast imaging sequences fetal motion is a problem
- Maternal discomfort & claustrophobia
- Lower resolution than US (cannot use 3Tesla)
- Can not resolve small structures
- No blood vessel information (conventional MRI)
- More expensive than US
- Requires good, dedicated fetal-neuro-MR expert
- Usually useful only after 24-28 weeks
- Cannot use contrast media

Specific limitations of fetal neuro-MRI
- Since in many countries, there is a limitation of the gestational age at which it is possible to terminate the pregnancy, it is crucial to arrive at a Dx before that age
- ...and since the real value of MRI is past that age limit...
- ...in these countries the practical value of MRI may be significantly limited in the second trimester

Ultimately: The role of fetal MRI is:
- ....to clarify US diagnoses suggested by findings on fetal neuroscan
- ....to obtain additional information for prenatal counseling and management – surgery or postnatal therapeutic planning
- ....to more precisely locate extracranial anatomy and other fetal pathology
- ....in patients high risk for brain anomalies. But remember: only after a good neuroscan

Let us now look at the use and indications of US & MRI in specific pathologies

Defects of the Neural Tube
- **US** “sufficiently good and enough” in:
  - Anencephaly/Exencephaly (even at 9-10w)
  - Holoprosencephaly (as early as 9-13 W)
  - Encephalocele
  - Chiari malformation
  - Assessing anatomical level of spinal defect

- **MRI** in most cases NOT NECESSARY

Posterior fossa abnormalities
- Challenge for both modalities due to late development of cerebellar hypoplasia-atrophy
- Development can be seen with both
- TV US and 3D improve assessment.
- **Median plane crucial for vermis** (still not a mandatory plane!)  
- **MRI** may be useful to rule out or dx cerebellar telangiectasia

**Tumors**

- **MRI**: This is where MRI excels - useful in characterizing of lesion
  - Excludes areas of hemorrhage or necrosis
  - Differential dx with hematomas
  - Confirms dx of lipomas
  - Dx intracranial nodules of tuberous sclerosis (small nodules)

**Microcephaly**

- **US**: If, because of poor acoustic windows, intracranial anatomy is not well depicted (mainly in advanced gestation) MRI may be helpful
  - Think ZIKA!

**Cortical development anomalies**

- **MRI**: Probably its most valuable contribution
  - **NEW**: DWI Assesses premyelinating formation of white matter tracts
  - Assessment normal migration.
  - More accurate in assessing the transient zones or layers of fetal brain parenchyma

- **US**: However, in the last several years US transducer technology & better understanding of images TVS is catching up
  - 

**Corpus callosum and the cava**

- **US** can be much better than MRI in dx of comissural anomalies (AGCC and SOD).
  - Doppler is important

**Absence of CSP**

- **US** is better with high expertise
- **MRI** can narrow the differential dx of:
  - Minor forms of lobar holoprosencephaly
  - Closed lip schizencephaly

**Optic chiasm**

- **MRI**: Clearly superior in evaluating OC and intracranial part of the optic nerves, hypophysis, olfactory structures.

- **3D US**: Reference ranges of Optic Chiasm recently published but not easily reproduced

**Ischemic lesions- Hemorrhage**

- Both **US** and **MRI** are complementary in accurate dx of germinal matrix and IVH

- **MRI**
  - High sensitivity detecting hemorrhagic lesions
  - Images well brain parenchyma

**Thrombosis of the torcular**

- Easy US diagnosis!
- **US**: Similar to **MRI**. MRI does not add much to it
CMV congenital infection

- US and MRI complement each other
- Recent retrospective study: US alone has better sensitivity than MRI alone.
- Both together increase Se, Sp, PPV, NPV for detection of brain lesions
  - Isolated VM: US sufficient
  - Subependymal cysts: US better
  - Mild microcephaly: MRI discriminates better
  - Calcifications: US more sensitive than MRI

Isolated Ventriculomegaly

- Remains unclear if MRI is better for the diagnosis of brain anomalies associated with VM, or depends on the expertise of the operator
  Malinger G et al, 2002 - His new articles continue this claim.
- Some studies recommend it when VM >12 mm and is mandatory when “isolated” VM increases in size over time

More on ventriculomegaly later!!

- Garel 2008, Salomon et al., 2006

As I personally see (so do many of us who advocate the value of US in evaluating the fetal brain), some Ob/Gyn and MFM practitioners are too quick to refer women to fetal MRI at the slightest deviation of a normal brain (and also other organs) seen at the routine US scan of fetal anatomy

My Plan

- I selected several articles on the subject
- This series of slides contain my, as well as some of my fellow US oriented friends views reflecting a collective and critical analysis of the selected articles.

Few take the time to check what the literature has to offer on the subject of US and MRI

Unfortunately the superficial reader of articles will see – and quote - the following:
The learning curve of diagnostic US in general, similarly to the learning curve of individuals who operate the constantly improving hardware, evolves and improves.

I expected that the current US and MRI literature dedicated to the fetal CNS may reflect this.

Did you pay attention to the year the articles were published?

All were published before 2005 with two in 1994.

The devil is in the detail

- To understand articles, one should read their M&M section!
  - How were patients selected or excluded
  - What kind of US was performed & at what gestational age
- Was it at the time of a routine transabdominal anatomy scan?
- Or, was it at a targeted neuroscan?
The devil is in the detail

• Furthermore:
  – What is the expertise of the sonologist
  – Who read the MRI & at what GA
    • Was it read by an MRI "generalist" reading all kinds of MRI?
    • Was it a dedicated neuro MRI person? (or at least a fetal MRI person??)
  – What experience has the MRI center

To set the record straight, I reviewed and present here several articles and their projected message when the use of US is compared to MRI. I am reviewing their M&M that lead to their biased interpretation

First article: Twickler D 2003

• Setting: fetal US suspected CNS anomalies
• Study design: Multiplanar MRI
  – MRI evaluated for additional info, and change the Dx, or impact obstetric RX.
  – Patients were grouped by gestational age

Results: 72 cases, MRI provided:
  – additional information in 46 (64%),
  – changed the Dx in 20 (28%), and
  – altered timing/delivery mode of in 8 (11%).
  – Additional info’ increased with increasing GA.
Conclusion: MRI provided additional information in two thirds of the fetuses with CNS abnormalities, which increased with increasing GA.
Antenatal treatment was influenced by MRI in 11% of the cases

• Unfortunately, the M&M is missing crucial information:
  1. The GA at the US scans and MRI studies
  2. The scanning route is not specified (TAS and TVS?)
  3. The US equipment and transducer frequencies used?
  4. The experience of the sonographers/sonologists?
  5. The US images are of less-than-diagnostic quality
  6. The MRI and the “matching” US images were taken at different planes; therefore, no comparison is possible.
• Reading carefully: MRI did not add substantially to the change of the management in the eight patients.
• All or almost all the diagnoses could have been made accurately by US performed by experienced sonologists/sonographers, use of good machines, and the addition of high-frequency TVS (if vertex presentation)
• 7. Unfortunately, one gets the false impression that MRI necessarily improves accuracy of DX.

In fact, the REAL message of this article is: MRI seems to be better than a technically substandard US.

The overall 19% disagreement between the MRI findings can easily be equaled by a good serial coronal, sagittal, and axial scanning (possibly by TVS), making the MRI scan redundant.

Second article: Benacerraf 2007

What Does Magnetic Resonance Imaging Add to the Prenatal Sonographic Diagnosis of Ventriculomegaly?

Beryl R. Benacerraf, MD, Thomas D. Shipp, MD, Bryan Bronley, MD, and Deborah Levine, MD

• M&M: GE730, TVS only on Vertex, 3D “only few”
Results: 26 fetuses 17 to 37 wks
• MRI showed 2 pathologies not seen by US
• Additional findings seen with MRI in 10
• There were “significantly more” fetuses with additional CNS anomalies found by MRI
• Conclusions Although sonography is accurate for the evaluation of fetuses with VM, MRI adds important additional information, particularly in fetuses with findings other than an enlarged ventricle

Second article: Rossi/Perfumo 2011

However, even in this relatively objective article:
• M&M:
  – GE730 (old version!) machine used,
  – TVS used only when Vertex (?#?),
  – 3D used “only in few cases” (?#?)
Objectives:
- Lit search - additional value of fMRI in assessing CNS anomalies suspected by US
- Methods
- Search PubMed, EMBASE, Cochrane lib.
- Inclusion criteria were CNS anomalies suspected/diagnosed by US
- MRI performed after US, no info if basic or targeted
- Outcomes assessed were
  - positive/negative agreement between US and MRI,
  - additional information provided by MRI, and
  - discordance between ultrasound and MRI

Results:
- 13 articles identified with 710 fetuses.
- MRI confirmed US-positive findings in 65.4%; provided additional info. in 22.1%.
- MRI disclosed CNS anomalies in 18.4% of fetuses.
- In 2.0% of cases, US was more accurate than MRI.
- In 30% MRI was so different from US that the clinical management changed.
- Agreement observed: 51.3%.
- Disagreement mainly for midline anomalies (48.6%).
- Pooled sensit of MRI: 97% & pooled specific: 70%.
- Conclusions MRI supplements information by US. It should be considered in selected fetuses with CNS anomalies suspected on US.

1. Only two of the 13 studies included were performed after 2007 (the year ISUOG published guidelines on CNS US).
2. Only 3 studies described the US protocol (3D & TVS).
   In contrast, the MRI sequences and the planes used were described in all cases.

One of their tables shows clearly that the inaccuracy in the US diagnoses was not the fault of the equipment but of the operator.

My conclusions: we should understand that this systematic review 'compares apples and oranges'

Before one can conclude that MRI provides additional value to US, a large, multicenter study comparing dedicated contemporary neurosonography with MRI is required.

This was not the last word in this "Apples and Oranges" scientific duel

Further rebuttal of Rossi-Perfumo
Dario Paladini -- one of the most trusted Italian MFMs and fetal neurosonologist writes:

D. Paladini  Fetal Medicine and Surgery Unit, G. Gaslini Institute, Genoa, Italy
Additional value of fetal magnetic resonance imaging in the prenatal diagnosis of central nervous system anomalies: a systematic review of the literature & related correspondence. A plea to assess oranges only.

- The aim of the systematic review reads: 'to evaluate the additional value of fetal MRI in the detection of CNS anomalies suspected by US.'
- Stated in these terms, the aim covers apples and oranges.
- On one hand, it may refer patients sent to MRI because in the screening setting the suspicion of a CNS anomaly was raised (without being referred initially for neurosonography) – the apples.
- On the other hand, it may refer to cases evaluated thoroughly with TV neurosonography, being sent only after this for Level-II MRI, with a specific indication – the oranges.

Also, in the very same paper, almost half of the MRI were performed before 24 weeks and more than 20% before 22 weeks.
This is probably why the results of the systematic review indicate much greater relevance of MRI than is usually perceived by the fetal neurologist, who, correctly reaches the final diagnosis only by US in the majority of cases referred for expert opinion.
- The misunderstanding is perpetuated in selecting articles in which ‘fetal MRI is performed after US’;

In conclusion, if the indication for MRI is correct, the clinical relevance of this additional examination is in the range of 5–10% (Malinger et al & our study).
- However, the real point is to underscore that, as far as fetal CNS anomalies are concerned, the diagnostic path should be from the screening setting to neurosonography and, only if the neurosonologist deems it appropriate, to MRI, with a defined diagnostic query for the neuroradiologist.

Since the “basic” and the “targetted fetal neuroscan” were mentioned without their proper definition, I would like to do this in several slides. This may shed light on the previous discussion and help in evaluating articles about the issue of US and MRI in general, and specifically in respect to the fetal CNS.
Basic Brain Scan: Using the 3 compulsory Axial Planes

Performed by the 2nd trimester fetal anatomy scan

Fetal neurosonogram = detailed 2D scan or 3D multiplanar imaging
- This looks at the brain in greater detail
- Coronal and sagittal planes are included
- Can be performed
  - transabdominally, and/or
  - transvaginally...using
  - 2D and/or 3D sonography

Targetted Fetal Neuroscan
Transvaginal/transabdominal sonography: using Coronal & Sagittal planes

The brain structures
- Anterior horns
- Posterior horns
- 3rd and 4th ventricle
- Interventricular foramina
- Cavum septi pellucidi
- Corpus callosum
- Pericallosal artery
- Caudate nuclei
- Thalami
- Cerebellum & vermis
- Cisterna magna
- Interhemispheric fissure
- Fissure
- Sphenoidal bone
- Ocular orbits
Not surprisingly, the performance of the two exams is radically different.

Fetal MRI is an important diagnostic imaging adjunct to US, particularly for the assessment of fetal brain.

A 2014 ISUOG survey of 60 international perinatal centers showed that fetal MRI is performed in at least 27 countries.

However, imaging quality, sequences used and operator experience appear to differ widely between centers.

The impact of such differences should be reduced by development of guidelines to define better the role of fetal MRI in relation to prenatal diagnostic US.

The aim of this document is to provide information on state-of-the-art fetal MRI for those performing the examination, as well as for clinicians interpreting results.

What is the purpose of fetal MRI?

To complement an expert US examination, either to confirm the US findings or to acquire additional information.

MRI is not currently used as a primary screening tool in prenatal care, although standardized and complete assessment of the fetal anatomy is probably feasible.
Results of ISUOG survey on indications for fetal MRI, rated on a scale from 0 (fetal MRI not at all indicated) to 7 (definitely an indication for fetal MRI).

- Under which circumstances should fetal MRI be performed?
- There is general consensus that fetal MRI is indicated following an expert US examination in which the diagnostic information about an abnormality is incomplete.
- Under these circumstances, MRI may provide important information that may confirm or complement the US findings and alter or modify patient management.

Underlying factors influencing the decision to perform fetal MRI include, but not limited to:
- experience/equipment of US and MRI sites
- accessibility to MRI
- maternal conditions
- gestational age
- safety concerns
- legal consideration regarding termination of pregnancy (TOP) and
- parental wishes after appropriate counseling

The multidisciplinary team: proposed participants and their role in performing fetal magnetic resonance imaging (MRI)

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In general, performance of an US examination following only the minimum recommendations for second-trimester ultrasound/basic brain examination, as proposed by ISUOG, is insufficient prior to requesting MRI.

Additional views, such as orthogonal views (3D), higher frequency probes and/or transvaginal imaging are required to detail the specific abnormality.

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NEXI is a series of 3 new articles published by the MERIDIAN group in the Lancet and the UOG in 2017

• **The goal** to assess whether
  - the diagnostic accuracy and confidence of the prenatal Dx of fetal brain abnormalities is improved with iuMRI and
  - assess the clinical impact and patient acceptability of iuMRI.


• **Methods** Common for all 3 articles:
  - 16 MFM centres, prospective, cohort study
  - Women ≥16 y. with a brain abnormality by US
  - **US** at GA of ≥18w (n=369) & ≥ 24w (n=201)
  - **IUoMRI** within 14 days of US.
  -Reviewed by 2 independent panels


**Use of MRI in the diagnosis of fetal brain abnormalities in utero (MERIDIAN): a multicentre, prospective cohort study**

Griffiths PD, Michael Bullough, Alistair Campbell, Cindy Cooper, Paul Gossen, Deborah Jones, Vini Dhillon, Cornwall Hospitals NHS Trust, and on behalf of the MERIDIAN Multicentre group.

**Lancet** 2017; 389: 538–46

**Article A**

**Interpretation of the results:**

• **IUoMRI improves Dx accuracy & confidence for fetal brain anomalies and leads to management changes in a high proportion of cases.**

• **This finding, along with the high patient acceptability, leads the authors to propose that any fetus with a suspected brain abnormality on US should have IUoMRI to better inform counselling and management decisions.**


**Anatomical subgroup analysis of the MERIDIAN cohort:**

**Ventriculomegaly**

Paul D Griffiths PhD FRCP*, Karen Brookes FRCOG DM*, Michael Bullough MBChB.

**UOG 2017 Accepted. On PubMed**

**Conclusion:** fetuses with ventriculomegaly as the only intracranial finding on US should be offered IUoMRI.

**Anatomical subgroup analysis of the MERIDIAN cohort:**

failed commissuration

Paul D Griffiths PhD FRCP*, Karen Brookes FRCOG DM*, Michael Bullough MBChB.

**UOG 2017 Accepted. On PubMed**

In conclusion, US has low diagnosis accuracy for abnormalities of the corpus callosum and the majority of the errors made on US are corrected by using IUoMRI imaging. A woman whose fetus has failed commissuration as the only intracranial finding on US should have IUoMRI imaging for further evaluation.
Opinion article. Our response to the 3 articles of the MERIDIAN study report. Accepted for publication in April 2017 by UOG

Opinion

Fetal cerebral magnetic resonance, neurosonography, the multiverse and the brave new world of fetal medicine

*Malinger, Paladini, Pilu, Tritsch; ACCEPTED by the Ultrasound Obstet Gynecol (available on PubMed).

- Stuart Campbell was the first to use the metaphor of the parallel universes discussing the utilization of US in pregnancy (**).
- The controversy around the use of MRI versus US to diagnose cerebral malformations is just another example in this regard.

- We postulated that the MERIDIAN studies were biased for different reasons, but that the most important one by far was an ambiguity defining the type of US compared to MRI.
- It is well recognized that there are 2 types of fetal brain US:
  - a basic exam, using axial planes is a screening exam done by an operator possibly, with limited knowledge of brain malformations
  - And, there is a dedicated fetal brain exam, or a neurosonogram, using a multiplanar approach and taking advantage whenever possible of the much better resolution of TVS (lately 3D!) and which is a diagnostic exam performed by experienced sonologists
- Not surprisingly, the performance of the two exams is radically different.

- The recent MERIDIAN Study……..
- ….. conducted in England, is just another example of faulty methodology.
- Claim that prenatal brain MRI:
  - changed prognostic information in 20% of cases
  - modified the management in 1 in 3 cases
  - And, there is a dedicated fetal brain exam, or a neurosonogram, using a multiplanar approach and taking advantage whenever possible of the much better resolution of TVS (lately 3D!) and which is a diagnostic exam performed by experienced sonologists
- We argue that this was a serious flaw in planning the study because it has been known since a long time that there are 2 different types of cerebral sonography

* Malinger, Paladini, Pilu, Tritsch: ACCEPTED by the Ultrasound Obstet Gynecol (available on PubMed).
– US nomenclature of the ViewPoint software used is an inadequate reference standard for indexing cerebral anomalies, excluding many of the most common abnormalities (e.g. AGCC, DWM, SOD, porencephaly, and CM).
– This is matter of serious concern, because
  • either the M&M was described incorrectly, or
  • they artificially restricted US DX to a handful of conditions that do not represent most anomalies
– We are surprised that this was not spotted by the referees.

**To conclude:**

**MRI can be of great use**

• For an “isolated” brain USI finding: may play role in providing reassurance
• For US findings of indetermined pathological significance
• To confirm or precise the extension of a well defined sonographic cerebral lesion (e.g. tumor)
• For prognostic purpose in some well defined pathologies
  • If identification of associated anomalies changes prognosis
  • If prognosis is correlated to the parenchymal extent of the lesions
  

**However, already in 2007, articles originating in the best Fetal MRI sites are acknowledging some of the issues they face**

**Diagnostic Pitfalls in Fetal Brain MRI**

Ali Al-Mukhtar, MD,* Gregor Kasprian, MD,† Maria T. Schmook, MD,‡ Peter C. Brugger, MD,* and Daniela Prayer, MD*†

Recent technological advances in fetal magnetic resonance imaging (MRI) and increased reliability of MRI in depicting abnormalities and lesions, especially in the fetal nervous system, are increasingly bringing up challenging issues with regard to accurate diagnosis. There are also pitfalls not only attributable to image acquisition but also in clinical interpretation. The misinterpretation of findings because of insufficient knowledge about fetal brain development as visualized by MRI may also be regarded as an important limitation of fetal MRI. We provide an overview of the most common pitfalls experienced in fetal MRI in routine practice, demonstrate how to identify signs of the features that lead to imaging misinterpretation, and suggest ways to tackle these problems, with an emphasis on MRI techniques and image evaluation.

Semin Perinatol 33:251-258 © 2009 Elsevier Inc. All rights reserved.

**Important to know the technique one uses: Pitfalls fetal brain MRI**

• Related to incorrect technique (choice of inadequate MRI sequences)
• Related to radiologic misinterpretation due to incomplete knowledge of prenatal brain development (anatomic landmarks according to GA)
• Artifacts (fetal or maternal movements, AF or CSF)
• Missed small structures due to low resolution: when slice thickness 3-5 mm.
• Nonorthogonal planes: may lead to misdiagnoses (in these cases US is superior) Need to standardize orthogonal views of the head

Al-Mukhtar , D Prayer, et al. Diagnostic Pitfalls in Fetal Brain MRI. Semin Perinatal 33:251-258

**The future**

3-D reconstruction of fetal brain for morphometric analysis

New technology in MRI:

- **Diffusion Tensor Imaging (DTI):** allows characterization of main fiber tracts (white matter anatomy) such as corticospinal tract, the somatosensory tracts and CC. (limitation: too sensitive of fetal and maternal motion)
- **MR spectroscopy:** obtains metabolic information from the brain, (hypoxic changes), adding information when there are only subtle changes on conventional MRI.
Conclusions

► **Basic US**: is a screening tool
► **Fetal neuroscan**: is a diagnostic modality
► US & MRI appear to be complementary in some anomalies and should not be mutually exclusive.
► In few entities MRI is clearly the method of choice.
► Both modalities are highly **operator dependent**.
► Both need an extensive knowledge of normal brain development.
► MRI is better than a poor US; conversely: a good US is much better than a poor MRI.
► First trimester: Today, no role for MRI.

Thank you for listening!

....And do read critically the M&M of articles!! 🕳️