

Classification of brain variants on fetal ultrasound: results of an international Delphi consensus

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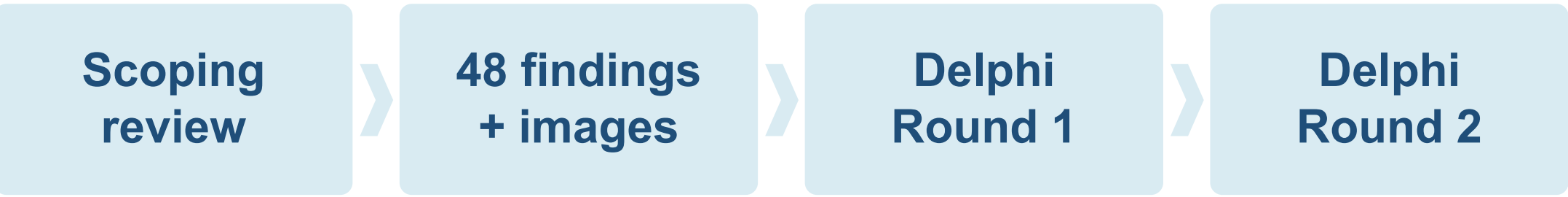
*Shared first authorship #Shared senior authorship | Fetal brain - Variant - Prenatal diagnosis - Ultrasound - Delphi consensus

Three-zone risk stratification for unusual fetal brain findings

OBJECTIVE

To develop an expert consensus framework to classify and manage fetal brain findings that cannot be confidently considered normal or pathological.

METHODS



* Two-round international Delphi survey of fetal medicine and neurosonography experts.

* 48 unusual fetal brain findings, each illustrated with ultrasound images.

* Classification: Green, Orange or Red; consensus predefined as >=70%.

EXPERT PANEL

48 experts in Round 1

14 countries

39 completed both rounds

Scope of the exercise

- * All trimesters of pregnancy
- * Findings ranging from likely normal variants to early markers of pathology
- * Evaluated as isolated ultrasound appearances

IMPORTANT READING RULE

The zones are a risk-stratification framework, not a definitive diagnostic algorithm.

Associated anomalies or abnormal clinical context should escalate management.

CLINICAL FRAMEWORK

Three predefined categories linked the level of concern to management.

Zone	Interpretation	Recommended management
Green	Normal variant	No additional investigation, cerebral MRI or specific ultrasound follow-up.
Orange	Uncertain significance / potential progression	Regular neurosonographic monitoring; no immediate MRI or genetic testing if isolated.
Red	Suggestive of underlying pathology	Dedicated neurosonography with consideration of fetal brain MRI and/or genetic investigations.

NON-CONSENSUS FINDINGS

13/48 findings (27%) remained uncertain after two rounds, reflecting persistent ambiguity in subtle asymmetries and selected cystic findings.

Green/Orange uncertainty

Atypical choroid plexus shape

Posterior ventricular asymmetry <10 mm

Large CSP / multiple cavum septations

Orange/Red uncertainty

Cisterna magna 10-15 mm

Blake pouch cyst without mass effect

Selected periventricular pseudocysts

MAIN RESULTS

Consensus was reached for 35/48 fetal brain findings after two Delphi rounds.

35/48

findings reached consensus

73%

overall consensus rate

13

no consensus items

Final classification of the 48 evaluated findings



DETAILS OF THE CLASSIFIED FINDINGS

Green (n=12)

- First trimester asymmetric shape of plexus choroid
- Asymmetric size or shape of plexus choroid with reduced fluid space at first trimester
- Altered echogenicity of the choroid plexus at first trimester
- Isolated choroid plexus cyst (1st/2d/3rd trimester)
- Single isolated cavum septation
- Isolated small size of CSP with intact corpus callosum in the 2d/3rd trimester
- Isolated dolichocephaly with normal HC / brain
- Isolated cavum vergae
- Isolated cavum velum interpositum

Orange (n=7)

- Marked asymmetry size of plexus choroid
- Choroid plexus cyst with a low maternal serum b-HCG
- Choroid plexus cyst > 10 mm
- Bilateral choroid plexus cyst
- Isolated enlarged intracranial translucency
- Blake's pouch cyst without mass effect
- Isolated unilateral or bilateral single anechoic periventricular pseudocysts along the anterior / posterior walls
- Isolated cyst of the CSP
- Isolated enlargement of the subarachnoid space
- Isolated asymmetric depth of cortical fissures

Red (n=16)

- Enlarged intracranial translucency
- Brainstem-vermis angle > 45 ° (1st trimester)
- Decrease brainstem-occipital bone diameter (1st trimester)
- Asymmetric frontal horns + dysmorphic appearance
- Isolated mega cisterna magna > 15 mm
- Mega cisterna magna with mass effect
- Isolated cyst next to the lateral ventricle + hyperechogenicity of the white matter
- Macrocephaly + isolated symmetric enlargement of subarachnoid spaces
- Enlargement of subarachnoid spaces + septations or echogenic irregularities
- Isolated thick corpus callosum in 3rd trimester
- Isolated distortion of the interhemispheric fissure
- Dolichocephaly + a leering fetal profile
- Dolicocephaly + exaggerated anterior intracerebral acoustic shadowing cone

Non-classified (n=13)

- Isolated atypical shape of plexus choroid,
- Multiple (>2) choroid plexus cyst (first trimester),
- Posterior ventricular asymmetry with diameter < 10 mm
- Asymmetric frontal horns (normal shape)
- Isolated mega cisterna magna 10-15 mm
- Isolated multiple cavum septations
- Isolated large CSP with normal size BPD
- Isolated thick corpus callosum in second trimester

CONCLUSION

This Delphi consensus proposes the first expert-derived classification of common fetal brain variants on ultrasound across all trimesters.

Prospective multicenter studies with postnatal imaging and neurodevelopmental outcome correlation are required before routine implementation.

ILLUSTRATIVE CLASSIFIED EXAMPLES

One representative example for each zone, using figures from the manuscript.

Green zone

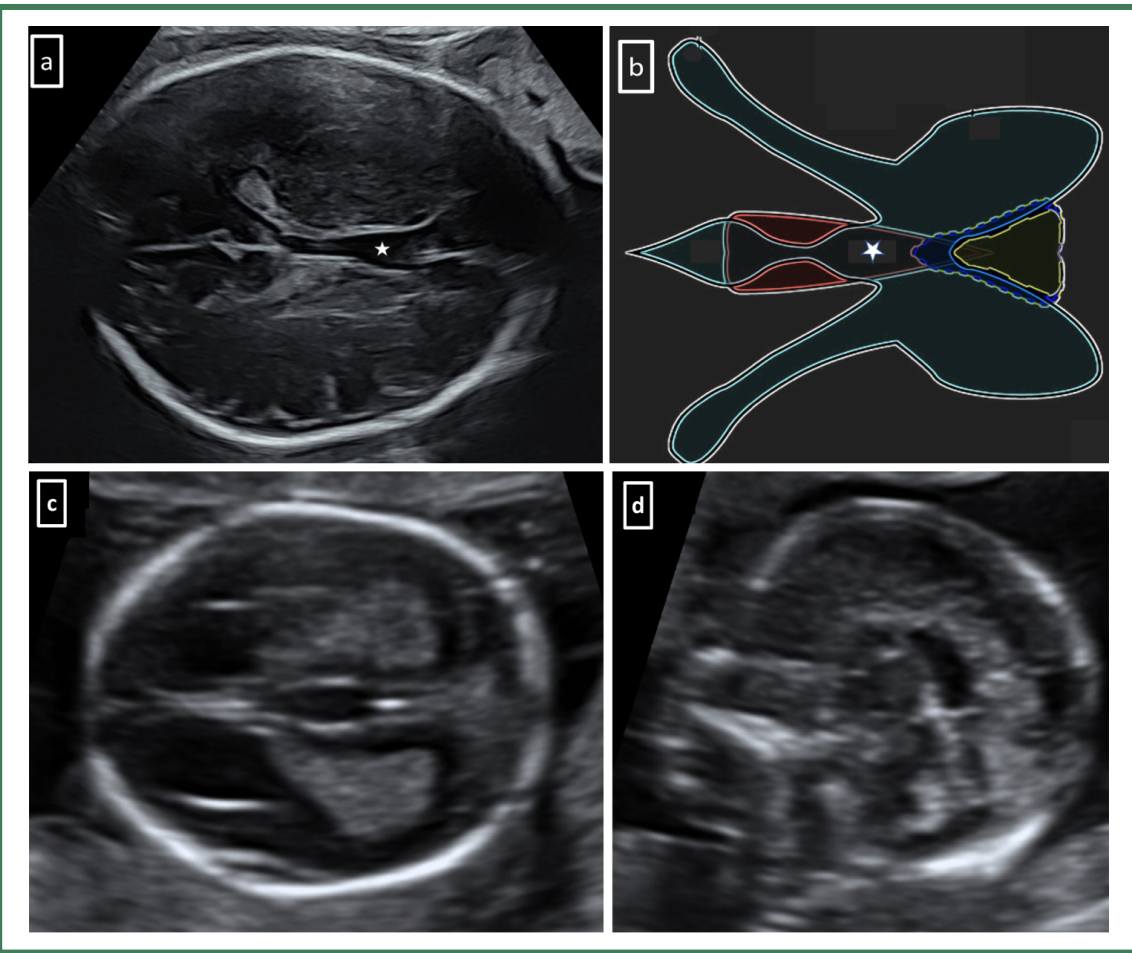


Figure 1. Cavum vergae (a and b) - Cavum velum interpositum (c and d)

Orange zone

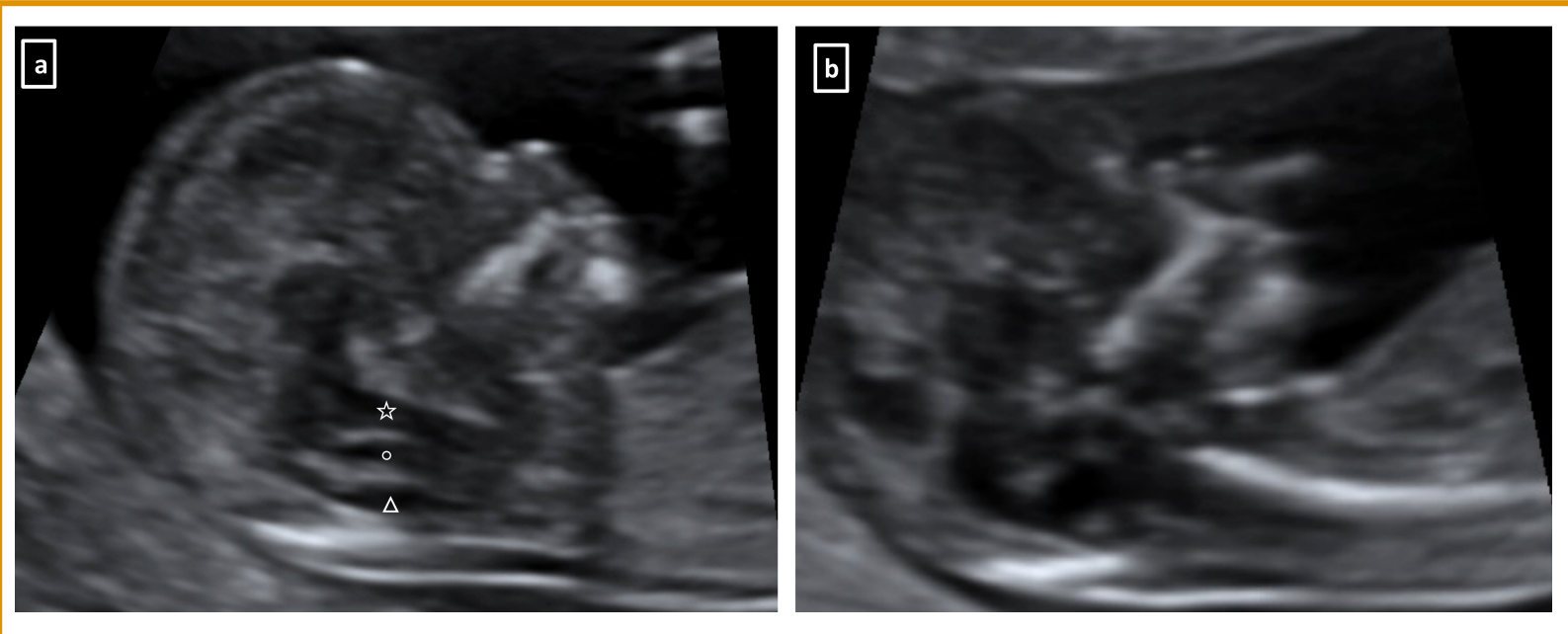


Figure 2. Enlarged intracranial spaces. In (a), clear identification of the brainstem (star), the intracranial translucency (circle) and the cisterna magna (triangle). In (b) enlarged intracranial translucency in a fetus without chromosomal anomalies.

Red zone

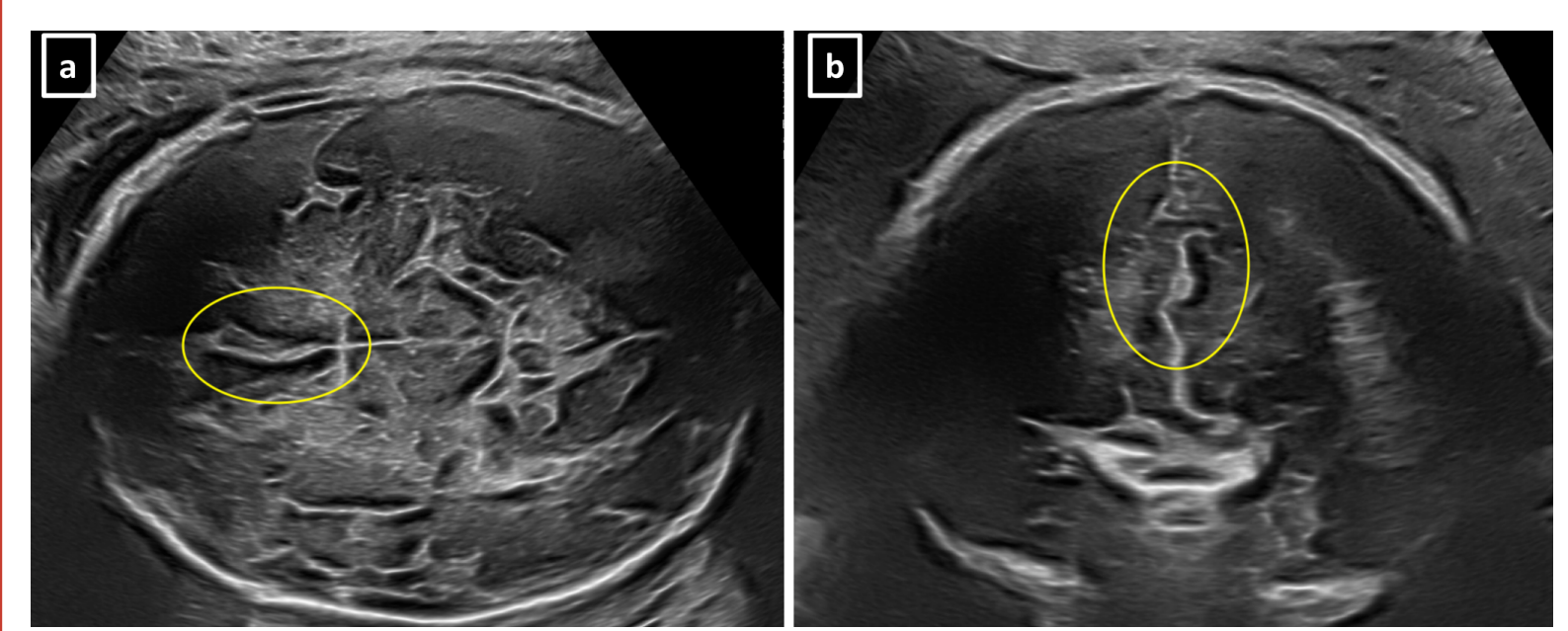


Figure 3. Distortion of the interhemispheric fissure at 32 WG

TAKE-HOME MESSAGE

When a fetal brain image is neither clearly normal nor clearly pathological, the Delphi framework provides a structured first response:

1. Recognize a possible variant
2. Classify the level of concern
3. Adapt follow-up: reassure, monitor or escalate

A framework for standardized communication and triage, pending prospective validation.