The Median Plane of the Brain
What does it add over the conventional axial views?

Ana Monteagudo, MD

Outline
- Definition
- Obtaining the median plane
- Sonographic anatomy of the median plane
- Examples of anomalies seen on the median section of the fetal brain

Why Is It Important to Obtain the Median Plane of the Fetal Brain?
- Allows easy, reliable & quick imaging of the
  - Corpus callosum
  - Tectal (quadrigeminal) plate
  - Posterior fossa
    - Vermis
    - Arteries, veins, and sinuses
- Aids in the diagnosis of abnormalities involving these structures

Median Plane*
Definition:
A vertical plane through the midline of the head/brain that divides it into right and left halves.

* Most use “Mid-sagittal”, a term the official Nomina Anatomica (Basel) does not endorse

Median Plane Transabdominally
Transfrontal view*
- Requires a good acoustic window (300 cc in bladder if TAS is used)
- Sagittal imaging through the anterior fontanelle or metopic suture results in excellent quality images but at times may be hard to access

3D: Transabdominally
The X, Y and Z controls (knobs) perform rotations around their respective axis

*Visentin et al., 2001
3D TAS Acquired Volume

Generate the median section very slightly off the midline

Median plane Transvaginally

• The anterior fontanelle provides an acoustic window resulting in high resolution and detailed images

Anatomic structures imaged in the median plane

• Corpus Callosum
• CSP ( & Vergae)
• Thalamus (3rd ventricle)
• Tela chroidea
• Tectum (corpora quadrigemina)
• Posterior fossa
  —Cerebellar vermis
  —Cisterna magna
  —4th ventricle
  —Fastigium

Embryological Aspects
Corpus callosum & cavum septi pellucidi

• The development of corpus callosum is closely associated with that of the CSP
  —There cannot be a CSP without a covering corpus callosum
  —However, a corpus callosum can be present in the absence of the CSP such as in septal agenesis as the result of SOD

Embryological Aspects
Corpus callosum & Pericallosal arteries

• Before 18 weeks, using only gray scale, the corpus callosum may not be evident.
• However, using color Doppler the pericallosal artery is a proof of its presence

Pericallosal arteries at 11-13 weeks

• Several authors have demonstrated the presence of the pericallosal arteries in the 1st trimester using 2D and 3D Power Doppler
• Few are aware and use this. It may be uses to screen pregnancies at increased risk of AGCC

Conturso R et al. Fetal Diagn Ther 2015;37:305–309
Embryological aspects of the corpus callosum & pericallosal arteries

- Normal pericallosal arteries should predict normal development of the corpus callosum

Sonographic appearance of the corpus callosum & cavum septi pellucidi

- Corpus Callosum:
  - Hypoechoic
  - C-shaped
  - Consistently seen after 18 wks

- CSP:
  - Fluid filled space
  - Consistently seen after 16-17th wks

Corpus callosum

- The corpus callosum has several parts: the rostrum (beak), genu (knee), corpus (trunk) and the splenium (tail)

Cavum Septi Pellucidi

- The posterior space of the CSP is the cavum Vergae

Sonographic appearance of the corpus callosum

- Tail extends to quadrigeminal cistern (tectal plate)

Tectal Plate (Quadrigeminal Plate)

- It is the portion of the midbrain tectum upon which the superior and inferior colliculi sit.
- Corpus callosum reaches it
A figure of 3 outlines the choroid plexus of the 3rd ventricle covering the thalamus and the choroid plexus of the quadrigeminal plate.

Adult-like appearance achieved during the 3rd trimester.

Posterior Fossa

Why is the Tentorium important?

Because: It’s elevation is a sensitive indicator of posterior fossa pathology.

The Vermis

The median plane

- Is the best plane to evaluate the vermian structures
- Echogenics
- Vermis ‘sits’ on the brainstem

Tentorium/Torcular

Vermis

4th Ventricle

Fastigium

Pons

Cisterna magna
**Arteries, Veins & Sinuses**

- Median plane is best to image vessels that are in the midline
- Color/power Doppler reveals both the arterial and the venous system

**Arteries**

- Callosomarginal a.
- Pericallosal a.
- Anterior cerebral a.
- Basilar a.

**Veins & Sinuses**

- Superior sagittal sinus
- Internal cerebral v
- Great vein of Galen
- Straight sinus
- Transverse sinus

**Pericallosal arteries**

- Paired vessels
- Its presence predicts a normal corpus callosum

**Torcular Herophilli a.k.a Confluence of the sinuses**

- The point where the superior sagittal sinus, straight sinus and occipital sinus meet: hence the name

**Why is the Confluence of the Sinuses or Torcular Herophilli important??**

- Because: It’s elevation is a sensitive indicator of posterior fossa pathology
Vein of Galen

- Located in the cistern of the velum interpositum and quadrigeminal cistern
- Recognizable by its “kink”

Development of Vein of Galen

- With advancing gestational age the vein of Galen develops its typical kink

Vein of Galen & Confluence Sinus

- Superior Sagittal Sinus
- Inferior Sagittal Sinus
- Internal Cerebral Vein
- Great Cerebral Vein
- Straight Sinus
- Confluens

Selected Anomalies that disrupt the median plane

- Disorders of the corpus callosum
  - Complete agenesis (absence)
- Tectal plate cysts
  - Cavum vellii interpositi, Arachnoid cyst
- Vein of Galen aneurysm
- Thrombosis at the torcular
- Posterior fossa abnormalities
  - Dandy-Walker Malformation
  - Blake’s pouch cyst
  - Megacisterna magna

Agenesis of the corpus callosum

- It is typically suspected in the axial plane
- US findings are:
  - Non-visualization of the normal CSP
  - Ventriculomegaly (> 10mm)
    - In VM abnormalities of the corpus callosum seen in 13 %*
  - Isolated in about 24%
    - The rest may have CNS, karyotypic, or another major abnormality


Agenesis of the corpus callosum

- Heterogonous condition
  - 1:4000 to 1:5000 livebirths
  - 2-3% in the developmentally disabled population
  - Cause may be genetic, infectious, vascular or toxic
3D Diagnosis of AGCC – Median Plane

- Absent
  - corpus callosum
  - cavum septi pellucidi
  - pericallosal artery

Median Plane Direct Sonographic Signs

- Absent corpus callosum & CSP
- ≥ 25 wks absent CG, radial array of sulci in a ‘Sunburst’ appearance

Absent Normal Pericallosal Arteries

Other findings: AGCC

- Midline interhemispheric cyst
  - Upwardly displaced 3rd ventricle
  - Most often seen in the 3rd trimester

AGCC, Interhemispheric cyst and Dandy-Walker Malformation
**Tectal plate cysts**

Cavum Velum Interpositum (CVI) Cysts

- Physiologic structures without clinical importance*
- Triangular in shape


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**Cyst of the Tectal Plate: CVI vs. Arachnoid Cyst**

- When cyst > 1 cm in the axial transverse plane; may cause a mass effect

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**Cyst of the Tectal Plate**

- Differential diagnosis CVI, arachnoid cyst, pineal tumors, hematoma, vein of Galen Malformation etc..
  - Color Doppler aids in the diagnosis

**Vein of Galen Aneurysm (VGAM)**

- Suspected in the axial plane
  - When a tubular structure located superior to the thalamus; and is contiguous with the dilated sagittal sinus


**VGAM – ‘Comet Tail’**

- Median plane it appears as an anechoic elongated (sausage-shaped) cystic structure behind the corpus callosum and cavum septi pellucidi
  - Color Doppler demonstrates turbulent flow
Vein of Galen Aneurysm (VGAM)

- Associated sonographic features in up to 76%:
  - Cardiomegaly in 64%
  - Other signs of heart failure: tricuspid insufficiency, polyhydramnios, pericardial and pleural effusion, edema and ascites

Thrombosis in the Torcular

- Suspected on the 2D axial plane
- Anechoic mass in the occipital region of the head
  - Lateral ventricles are within the normal range
- Typical presentation in the 2nd trimester

Thrombosis at the Torcular

- Large supratentorial anechoic mass within it is a bright structure: a clot; may extend to straight sinus and vein of Galen
  - Color Doppler demonstrates no flow

Thrombosis at the Torcular – 39 wks

Thrombosis at the Torcular

The superior sinus is displaced, pushed anteriorly by the thrombotic process.

Anomalies of the Posterior Fossa
Increased Cisterna Magna Fluid

- Suspected in the axial plane
- May be difficult to reach a final conclusion about its etiology without additional imaging.

Median Plane in The Differential Diagnosis of Increased CM Fluid

- Results in:
  - Elevation of the Tentorium and Torcular
  - Upward displacement and rotation of the vermis
  - Degree of rotation varies with different pathologies

Dandy-Walker-Malformation

- Complete or partial vermal agenesis
- Cystic dilatation of the 4th ventricle (persistent BPC)
- Enlarged posterior fossa with upward rotation of vermis and elevation of the tentorium and torcular.

Mega cisterna magna

- Large cisterna magna measuring >10 mm in the transverse cerebellar plane, and a normal cerebellar vermis.
  - Absent hydrocephalus

Blake’s pouch cyst (Persistent Blake’s pouch)

- 3 criteria for diagnosis:
  1) normal anatomy and size of the vermis
  2) mild/moderate rotation of the vermis
  3) normal size of the cisterna magna

Vermian abnormalities (a.k.a DWM variant)

- In isolated V. hypoplasia the vermis is normally formed but small, posterior fossa normal.

Teaching Points

- BV angle is an objective finding useful in differentiating posterior fossa fluid collections
- BV angle < 18° was always found in the nl controls
- BV angle increases with increasing severity of the condition
- BV angle > 18° but < 30° suggests a dx. Blake’s pouch cyst
- BV angle > 45° is strongly suggestive of DWM
- BT angle showed similar pattern; but there was much overlap between the groups

Take Home Message

- The median plane should be routinely included in all anatomical surveys (≥20 wks) as part of the fetal brain scan.
- It adds information when an abnormality is suspected on the axial plane.
- It is a “must” in cases referred for second opinion due to a suspected anomaly.
Thank You