International Journal of Science and Research Archive
eISSN: 2582-8185
Cross Ref DOI: 10.30574/ijsra
Journal homepage: https://ijsra.net/

(REVIEW ARTICLE)

Check for updates

Congenital posterior fossa malformations: An imaging review for the practicing radiologist

Shrinivas Radder * and Nivedita Radder

Department of Radiology, University of Arkansas for Medical Sciences, Little Rock, Arkansas, USA.

International Journal of Science and Research Archive, 2025, 16(01), 1059-1079

Publication history: Received on 05 June 2025; revised on 12 July 2025; accepted on 14 July 2025

Article DOI: https://doi.org/10.30574/ijsra.2025.16.1.2113

Abstract

Congenital malformations of the posterior fossa represent a heterogeneous group of malformations affecting the cerebellum, fourth ventricle, and related structures, with improved implications for embryologic considerations, clinical management, and neurodevelopment. Evolving imaging, especially fetal MRI and high-resolution postnatal MRI, has cemented the responsibility of the radiologist in correct diagnosis, classification, and differentiation of these malformations. This imaging review attempts to present a synthesis concerning the embryological basis, diagnostic criteria, and characteristic radiological findings of important posterior fossa anomalies: Dandy–Walker malformation, Blake's pouch cyst, Chiari malformations, rhombencephalosynapsis, and mega cisterna magna. It further discusses critical diagnostic pitfalls and modality-specific imaging recommendations for prenatal and postnatal evaluations.

The embryological underpinnings of the hindbrain are explored to set a developmental perspective for understanding these malformations, followed by a system of classification based on neuroimaging pattern. Multimodality imaging techniques from prenatal ultrasound all the way to fetal and neonatal MRI have been examined with regard to their merits, demerits, and clinical applications. The discussion also deals with radiologic-pathologic correlations, promising approaches involving machine learning to segment the posterior fossa, and current trends in prediction of outcome. Tables and diagrams have been provided to help the practising radiologist to navigate through this complex diagnostic terrain.

Based upon recent neuroimaging literature, this article aims to bring together all available evidence, synthesizing it with clinical insights to provide the modern-day radiologist with a hands-on guide for daily interpretation and interdisciplinary cooperation within pediatric and prenatal contexts. Above all, it stresses the need for swift and accurate classification and communication by the radiologist, which, in turn, facilitates proper prognostication, parental counseling, and therapeutic decision-making.

Keywords: Posterior fossa malformations; Congenital brain anomalies; Fetal MRI; Dandy–Walker malformation; Blake's pouch cyst; Chiari malformation; Cerebellar development; Rhombencephalosynapsis; Neuroimaging; Pediatric radiology

1. Introduction

CPFMs are a diverse group of structural malformations that affect different aspects of the cerebellum, brainstem, fourth ventricle, and CSF spaces. Normally, these malformations arise when developmental phases get disturbed during the early embryology of the malformation. They can be detected by means of prenatal ultrasound and fetal MRI (Patel and Barkovich, 2002). Radiologists have become an integral part of the identification, classification, and distinction of posterior fossa alterations increasingly needed for clinical prognosis, surgical planning, and parental counseling (Barkovich et al., 1989) (Figure 1).

* Corresponding author: Shrinivas Radder

The posterior fossa is a very small compartment with a great density of functionally important neuroanatomical structures that control balance, muscle coordination, and autonomic functions. The complexity and tight spatial relationship of its components are such that the posterior fossa becomes a diagnostic challenge for both prenatal and postnatal neuroimaging. There is a full spectrum of CPFMs that run from benign variants like mega cisterna magna to very severe and syndromic conditions like Dandy–Walker malformation and rhombencephalosynapsis, often associated with hydrocephalus, callosal dysgenesis, or craniofacial anomalies (Barkovich et al., 1989; Klein et al., 2003).

The nomenclature and classification of posterior fossa malformations remain contentious topics despite,^ a gap of decades in clinical practice. Previously raised malformations were grouped mainly according to their appearances on neuroimaging-anatomical correlation along midsaggital sections, rather than through strict embryologic considerations (Kollias et al., 1993). This gives rise to much overlap in diagnostic nomenclature, further resulting in miscommunication among radiologists, pediatricians, neurosurgeons, and geneticists (Spennato et al., 2011). Hence a contemporary approach to imaging-based evaluation that embraces embryological development in combination with radiologic pattern recognition would be of great significance.

In an attempt to provide a clinical radiologist's roadmap, the review has attempted an integration of anatomy, embryology, and imaging in a way that provides a comprehensive yet practical approach to CPFMs. Table 1 shows the embryologic timeline for hindbrain development, while Table 2 introduces the major CPFMs with their associated imaging features. These lay the basic framework upon which the more difficult posterior fossa evaluation will be based.

Table 1 Embryological Timeline of Posterior Fossa Development

Developmental Stage	**Gestational Age**	**Key Events in Hindbrain Formation**	**Imaging Relevance**
Neural Tube Closure	~4 weeks	Rhombencephalon forms and segments into rhombomeres	Basis for cerebellar segmentation
Pontine Flexure	~5–6 weeks	Fourth ventricle expands; choroid plexus appears	Shape of fourth ventricle becomes visible on fetal MRI
Vermian Formation	~7–10 weeks	Vermis and hemispheres develop from rhombic lips	Early vermian agenesis detectable
Fissure Formation	~15–18 weeks	Primary and secondary fissures of the cerebellum appear	Vermian hypoplasia or dysplasia can be detected by MRI
Maturation Phase	~20+ weeks	Myelination begins; brainstem–cerebellar connections established	Final configuration observed in 3rd trimester imaging

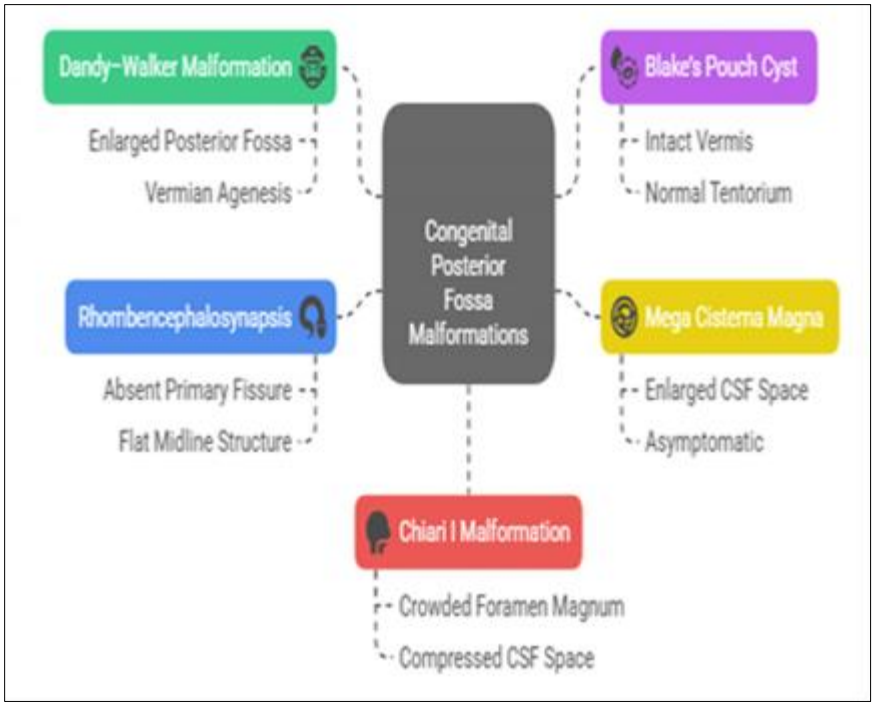
Sources: Barkovich et al. (1989); TortoriDonati and Norman (2011); Patel and Barkovich (2002)

Currently, several classification systems attempt to place these malformations along developmental-radiological lines. For example, the spectrum concept situates Blake's pouch cyst, Dandy-Walker variant, and Dandy-Walker malformation along the continuum of vermian and fourth ventricular anomalies (Patel and Barkovich, 2002). The consistent use of MRI diagnostic criteria and a thorough grasp of developmental neuroanatomy can go a long way toward reducing ambiguity in radiologic interpretations (Schaible and Goldstein, 2014).

This review will thus act as an educational piece and a practical imaging guide to help radiologists with the diagnostic conundrums posed by CPFMs. In the following sections, we cover embryologic bases, imaging considerations, and radiologic features of each anomaly, finishing with the evaluation of diagnostic pitfalls, trails toward clinical management, and avenues for the future.

Historically, posterior fossa abnormalities account for a minimum 20% and a maximum of 30% of all fetal intracranial anomalies detected on prenatal imaging, whereas Dandy–Walker malformation (DWM) alone occurs at a rate of 1 in 25,000 to 1 in 35,000 live births (Levine et al., 2008; Schaible and Goldstein, 2014). Fetal MRI has revolutionized prenatal detection, owing to superior tissue contrast and spatial resolution with respect to ultrasonography, particularly for midline structures such as the vermis and fourth ventricle (Truwit, 1991). With increased sensitivity came an increase in diagnostic dilemmas, including the need to differentiate between benign maturational delays and true hypoplasia or agenesis (Klein et al., 2003; Patel and Barkovich, 2002).

Many CPFMs occur as syndromic presentations. For instance, rhombencephalosynapsis is often seen with Gómez–López–Hernández syndrome, a rare neurocutaneous disorder characterized by alopecia, trigeminal anesthesia, and cerebellar dysfunction (Garcia-Heras and López-Sánchez, 2005). On the other hand, Chiari II malformation is almost invariably congruent with myelomeningocele and spina bifida, whereas DWM may be associated with agenesis of the corpus callosum, ventriculomegaly, as well as cardiovascular or craniofacial anomalies (Golden et al., 1987; Bindal et al., 1990). In such circumstances, proper neuroimaging will help in diagnosis and initiate genetic counseling, karyotyping, and a multidisciplinary approach.



Sources: Calabrò et al. (2000); McClugage and Oakes (2019); Spennato et al. (2011); Schaible and Goldstein (2014)

Figure 1 Congenital Posterior Fossa Malformations

From the perspective of prognosis, among the important imaging indicators of neurodevelopmental outcome are the degree of cerebellar vermis involvement, associated anomalies, and the level of hydrocephalus (Klein et al., 2003; Spennato et al., 2011). For instance, developmentally, most infants with Blake's pouch cyst will have normal or near-normal cognitive development. On the contrary, in cases of DWM, especially those associated with supratentorial anomalies, motor delay, cognitive impairment, and epilepsy frequently become manifest (Calabrò et al., 2000; Hammond et al., 2002).

During routine fetal screening or early postnatal assessment, the prenatal or pediatric radiologist will very often be the first specialist to alert the medical team to CPFMs. This diagnostic role is both technical and interpretive, requiring precise visualization of posterior fossa anatomy, knowledge of developmental neurobiology, and an awareness of subtle changes occurring during fetal brain maturation (Schaible and Goldstein, 2014). Equally important is the ability to communicate in a standardized actionable language with maternal–fetal medicine teams, pediatric neurologists, and neurosurgeons (Sadler et al., 2020).

In addition, AI and radiomics, recently integrated into neuroradiology, might usher in a new era of diagnostic reproducibility. Deep learning models showed early promise for the automated segmentation of the cerebellar vermis, classification of malformations on fetal MRI, and prediction of likely outcomes from shape and volumetric features (Qi et al., 2025). These tools, although not yet in widespread clinical use, may help reduce interobserver variability that undermines posterior fossa assessment, particularly in resource-limited settings.

Thus, the imaging of congenital posterior fossa malformations is no longer descriptive radiology. It has now evolved into an interpretive process that integrates embryological understanding, high resolution imaging, clinical correlation, and predictive analysis. The intent of this article is to provide the practicing radiologist with a framework based on literature evidence, and grounded in anatomy and visually guided for improved diagnostic capabilities, clearer communication, and better patient outcome in suspected CPFMs.

2. Embryology and Anatomical Basis

In order to fully comprehend congenital posterior fossa malformations, one must first understand the embryogenesis of the hindbrain, a rigorously ordered process that acts within a temporal window. Malformations in anatomy resulting from numerous mechanisms can take place if disturbances occur at a certain stage of development. The posterior fossa that contains the cerebellum, pons, medulla oblongata, and the fourth ventricle originates from the rhombencephalon, a structure that begins its formation during the fourth week of gestation (Tortori-Donati and Norman, 2011; Barkovich et al., 1989) (Figure 2).

The rhombencephalon is split into two main areas: the metencephalon, which forms the pons and cerebellum, and the myelencephalon, which develops into the medulla oblongata. This division occurs with the help of rhombomeres, which are increasingly recognized as transient embryological segments regulated by the actions of homeobox genes (Sadler et al., 2020). Spatially and temporally precise expression of these genes controls neuronal migration, axonal guidance, and midline fusion events that play an essential role in the development of the cerebellar vermis and hemispheres (Tortori-Donati and Norman, 2011).

Table 2 Hindbrain Derivatives and Their Embryologic Origins

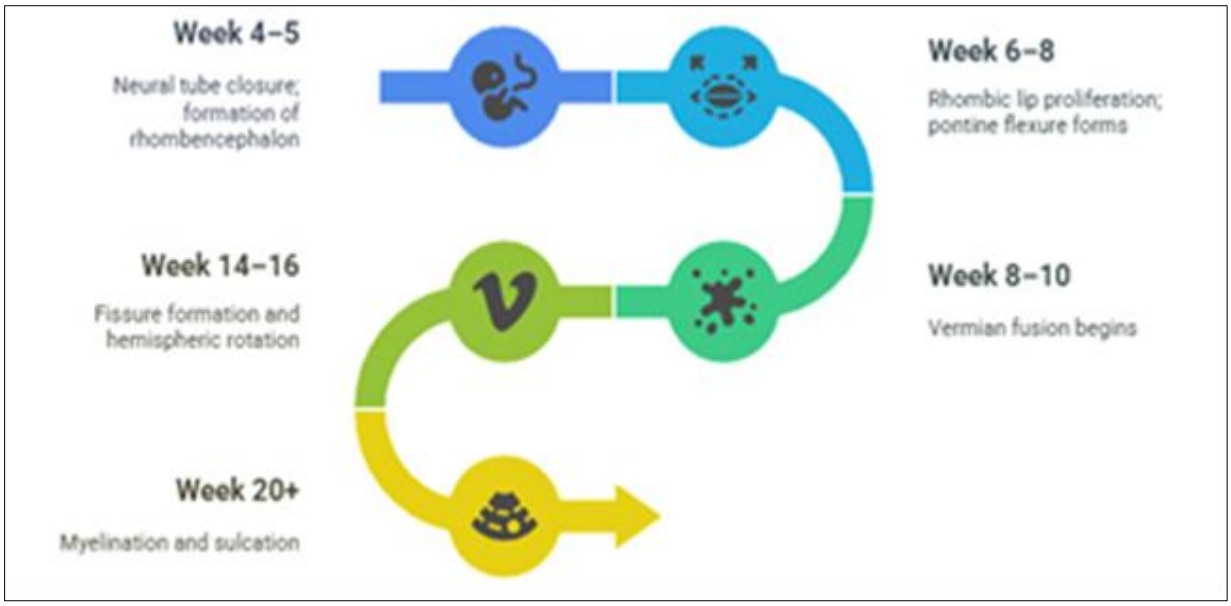
Rhombencephalon Division	Embryonic Derivative	Adult Structure Formed	Imaging Relevance in Malformations
Metencephalon	Alar plate of rhombic lips	Cerebellar hemispheres and vermis	Vermian agenesis, cerebellar hypoplasia
Metencephalon	Basal plate	Pons	Seen in pontocerebellar hypoplasias
Myelencephalon	Alar and basal plates	Medulla oblongata	Affected in Chiari II, brainstem anomalies
Roof plate of 4th ventricle	Ependymal cells	Choroid plexus of fourth ventricle	Dandy–Walker cyst, Blake's pouch cyst

Sources: Barkovich et al. (1989); TortoriDonati and Norman (2011); Sadler et al. (2020)

By the end of the 5th week, the pontine flexure initiates conversion of the dorsal part of the rhombencephalon to expand laterally, forming the primitive fourth ventricle, whereas at the same time, bilateral cerebellar primordia start to develop as rhombic lips. During weeks 6-10, lip structures migrate dorsally and medially to join at the midline, thus forming the vermis (Calabrò et al., 2000). Interruptions during fusion, especially genetic mutations, ischemia, or teratogenic insults, give rise to vermis hypoplasia or agenesis, and fusion of cerebellar hemispheres leading to rhombencephalosynapsis (Aldinger et al., 2018).

The posterior membranous area (PMA) and Blake's pouch are very important in CSF flow regulation and in determining the architecture of the posterior fossa. Blake's pouch originates from the PMA and normally disappears by the 9th week of gestation. Failure of its fenestration leads to a Blake's pouch cyst that is "invariably" misdiagnosed as a Dandy-Walker malformation or an arachnoid cyst (Calabrò et al., 2000; Azab et al., 2014).

The cerebellar fissures (including the primary, the posterior superior, and the horizontal) start forming after the 15th week and continue maturing well into the third trimester (Levine et al., 2008). Vermian fissures are especially important for identifying vermis hypoplasia (immature but forming) versus agenesis (complete absence), an distinction that is critical to radiologic interpretation (Klein et al., 2003).



Sources: Levine et al. (2008); Truwit (1991); Aldinger et al. (2018); Azab et al. (2014)

Figure 2 Cerebellar Development Timeline with Imaging Insights

Errors occurring at various stages within this timeline result in varied malformations. For example, Chiari malformations primarily result from an early mesodermal insufficiency, impeding the formation of the posterior lobe and thereby leading to small posterior fossa volume and the herniation of cerebellar tissue through the foramen magnum (Spennato et al., 2011). In contrast, Dandy–Walker malformation is alerted due to the nondevelopment of the PMA and vermis, which may be followed by cystic dilation of the fourth ventricle and an abnormally high tentorium (Barkovich et al., 1989; Golden et al., 1987).

Embryological origins can, therefore, separate malformations that share imaging features. For instance, in axial projection, a Blake's pouch cyst looks somewhat like an arachnoid cyst or a DWM, but the normally developed vermis and intact tentorium make it a non-surgical, often self-limiting entity (Calabrò et al., 2000; Azab et al., 2014).

Recollecting these embryologic sequences helps the radiologist in interpreting the developmental "snapshots" provided by prenatal imaging and in Gelatin's fingerprints of findings that may otherwise appear to be ambiguous or borderline. This equally brings forth the paramount significance of gestational age-specific MRI interpretation, especially in the latter half of the second and through the third trimesters, where many of these posterior fossa structures gain clarity in diagnosis (Levine et al., 2008).

3. Classification of Posterior Fossa Malformations

Traditionally, an accurate classification of congenital posterior fossa malformations (CPFMs) has been fraught with atypical terminologies, overlapping radiological features, and a distinct lack of correlation among embryological considerations and neuroimaging criteria. In their conception, the early anatomical systems considered essentially the gross morphological anatomy as identified in postnatal imaging or autopsy findings. The advent of high-resolution fetal MRI and excellent prenatal ultrasonographic images, however, has brought with it a more evolved pattern-based diagnostic classification dependent on the time of development, ventricular anatomy, vermis integrity, and overall size of the posterior fossa (Patel and Barkovich, 2002; Barkovich et al., 1989; Levine et al., 2008)(Table 3 and Figure 3).

Radiologists have now been pushed to consider CPFMs in terms of developmental continua rather than isolated entities. Interpreting require-make-the-hard distinguish pathologic malformations (requiring intervention or counseling) from developmental variants (that may remit or have no clinical consequence). A more refined classification will allow better prediction of outcomes and better surgical decisions, including coordination with other disciplines.

Table 3 Diagnostic Axes for Classifying Posterior Fossa Malformations

Diagnostic Axis	Descriptors / Categories	Clinical Importance
Vermis Status	Normal, hypoplastic, dysplastic, agenesis	Predicts motor/cognitive development (Klein et al., 2003)
Fourth Ventricle Anatomy	Normal, dilated, elevated, fenestrated	Key in distinguishing DWM vs. Blake's pouch cyst
Posterior Fossa Volume	Normal, enlarged, compressed	Enlarged in DWM, compressed in Chiari malformations
Cisterna Magna Size	<2 mm, 2–10 mm, >10 mm	>10 mm suggests mega cisterna magna or Blake's pouch cyst
Tentorial Elevation	Present or absent	Elevated in DWM, normal in others
Associated Anomalies	Present or absent (e.g., corpus callosum agenesis, hydrocephalus)	Essential for syndromic diagnosis

Sources: Barkovich et al. (1989); Levine et al. (2008); Patel and Barkovich (2002)

3.1. Dandy –Walker Continuum

The term Dandy–Walker complex or continuum reflects a spectrum of developmental disruptions having their prime target on vermian-fossa and fourth ventricular disturbances. They share common embryological origins; failure of regression of Blake's pouch and disturbed vermian fusion occurs between 6 and 10 weeks of gestation (Calabrò et al., 2000; Golden et al., 1987). Along this spectrum, the three syndromes are:

3.1.1. Dandy–Walker Malformation (DWM)

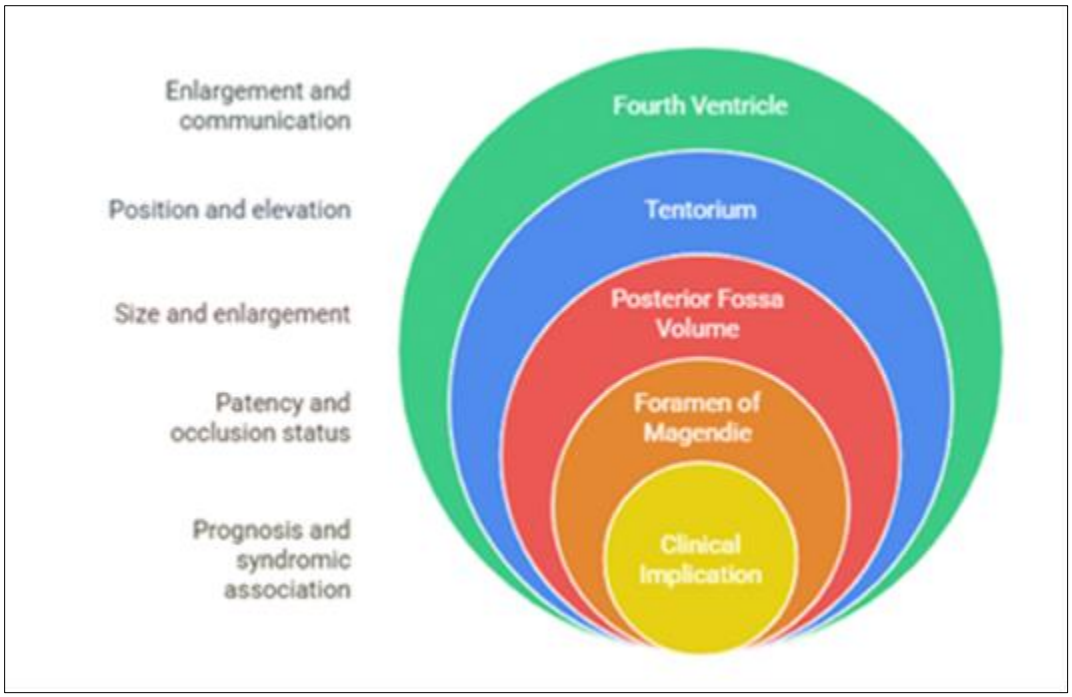
Characterized by cystic dilatation of the fourth ventricle, partial or complete agenesis of the vermis, and enlargement of the posterior fossa, with elevation of the tentorium and torcula. This classic triad is frequently accompanied by hydrocephalus and supratentorial abnormalities like corpus callosum agenesis and gyral anomalies (Barkovich et al., 1989; Spennato et al., 2011).

3.1.2. Dandy-Walker Variant

Once overutilized, it is usually not favored because of the lack of concrete definition. It usually refers to a mild hypoplasia of the vermis without enlargement of the posterior fossa (Patel and Barkovich, 2002). Currently, many experts prefer to specify the abnormality under consideration with more accurate terms such as "vermian hypoplasia with normal fourth ventricle" or "Blake's pouch cyst" based on imaging.

3.1.3. Blake's Pouch Cyst (BPC)

This cyst is caused by the nonperforation of the foramen of Magendie and manifests as a midline cyst inferior to an intact vermis, with normal tentorium and fourth ventricle morphology (Calabrò et al., 2000; Azab et al., 2014). It is often incorrectly diagnosed as DWM, but BPC has made a better prognosis and might even spontaneously resolve.



Sources: Calabrò et al. (2000); Azab et al. (2014); Spennato et al. (2011)

Figure 3 Posterior Fossa Malformations

3.2. Types of Chiari Malformations (I–III)

Chiari malformations are hindbrain herniation syndromes in which the cerebellar tonsils or other contents of the posterior fossa have been pushed down through the foramen magnum. Historically these malformations were thought to be acquired or mechanical in nature, but embryological studies demonstrate mesodermal insufficiency during the formation of the skull base as the probable cause (Sadler et al., 2020; Spennato et al., 2011).

Chiari I Malformation involves descent of the cerebellar tonsils ≥5 mm below the foramen magnum with a small posterior fossa volume. It is generally asymptomatic in children, although it may cause headaches, syringomyelia, or scoliosis in adolescents and adults (McClugage and Oakes, 2019).

Chiari II Malformation almost always associates with myelomeningocele. The caudal displacement involves the vermis, brainstem, and fourth ventricle, usually with hydrocephalus, tectal beaking, and supratentorial anomalies (Spennato et al., 2011).

Chiari III Malformation, being rare and most severe, consists of herniation of cerebellar contents into a high cervical or occipital encephalocele (Sadler et al., 2020).

3.3. Rhombencephalosynapsis

This rare anomaly is defined by complete or partial agenesis of the vermis with fusion of the cerebellar hemispheres, resulting in a transversely oriented folial pattern on axial imaging (Aldinger et al., 2018). It is often associated with Gómez–López–Hernández syndrome, which includes craniofacial dysmorphisms and trigeminal anesthesia (Garcia-Heras and López-Sánchez, 2005).

3.4. The Mega Cisterna Magna and Arachnoid Cysts

The Mega Cisterna Magna (MCM) is the CSF cistern in the brain with a retrocerebellar diameter of more than 10 mm in the presence of a normal vermis and fourth ventricle (Patel and Barkovich, 2002). Hence, this is often just a random observation and bears no clinical significance.

The arachnoid cysts are cysts with CSF that bear no communication, lined by the arachnoid membrane, displacing adjacent structures but without internal architecture. On MRI, the cyst appears isointense to CSF on all sequences and, unlike BPCs, does not communicate with the fourth ventricle (Schaible and Goldstein, 2014).

Correct classification of CPFMs is more than an academic exercise-counseling, surgical interventions, and prognostication all depend on it. Misdiagnosis especially between DWM, BPC, and MCM may lead to unnecessary surgical intervention or inappropriate assurance to the parents (Azab et al., 2014). Hence, classification has to be made with midline sagittal MRI and axial views with a keen consideration of the developmental anatomy and other associated anomalies in the clinical context.

MRI diagnosis will demonstrate absence of primary fissure and continuity of the cerebellar hemispheres across the midline. Associated supratentorial anomalies include aqueductal stenosis and absent septum pellucidum.

4. Imaging Modalities and Protocols

Successful evaluation of CPFMs critically depends on the use of appropriate imaging modalities depending on the patient's age, clinical status, and investigative concern. As the posterior fossa undergoes rapid developmental changes throughout gestation and early infancy, it becomes necessary to assess modal application and protocol optimization in the context of embryological timing and technical restrictions.

Prenatal ultrasound remains the most common first-line screening procedure, the advent of fetal MRI in conjunction with postnatal high-resolution MRI has revolutionized the ability of the radiologist to detect, differentiate, and offer a prognosis for posterior fossa anomalies (Levine et al., 2008; Schaible and Goldstein, 2014). CT and neurosonography still have their values in some settings—such as in unstable neonates or when hydrocephalus and bone anomalies must be evaluated.

4.1. Prenatal Imaging

4.1.1. Ultrasound

Typically, by the second trimester, obstetric ultrasound is the first tool suggesting pathology in the posterior fossa, usually during the routine anomaly scan performed at 18-22 weeks. The standard axial views include the transcerebellar diameter, cisterna magna, and cavum septum pellucidum to evaluate vermis development and posterior fossa fluid spaces. However, some limitations are poor visualization of sagittal midline structures, operator dependence, and the inability to reliably differentiate between normal developmental delay and pathology (Levine et al., 2008).

4.1.2. Fetal MRI

Fetal MRI is now established as the gold-standard prenatal evaluation method of the CNS when a posterior fossa abnormality is suspected on ultrasound. This allows exquisite contrast resolution, beautiful sagittal and coronal views, and precise visualization of vermian lobules, the fourth ventricle morphology, and the tentorial angle (Truwit, 1991). Typical sequences include T2-weighted SSFSE, balanced SSFP, and diffusion-weighted imaging (DWI). Usually, fetal MRI is performed at or after 20 weeks' gestation when the cerebellar vermis is reliably visible.

Table 4 Comparison of Prenatal Imaging Modalities for CPFMs

Feature	**Ultrasound**	**Fetal MRI**
Visualization of Vermis	Limited in midline view	Excellent in sagittal plane
CSF Space Assessment	Adequate for cisterna magna	Superior resolution and 3D coverage
Operator Dependency	High	Moderate
Motion Sensitivity	Low	High (mitigated with fast sequences)
Optimal Gestational Age	18–22 weeks	20+ weeks
Diagnostic Accuracy for DWM	Moderate	High

Sources: Levine et al. (2008); Truwit (1991); Schaible and Goldstein (2014)

4.2. Postnatal: Imaging

4.2.1. MRI

Postnatal MRI is a definitive procedure in the evaluation of CPFMs owing to its capacity to demonstrate both the structural anatomy and myelination patterns. High-resolution 3D sequences, T1- and T2-weighted, from planes of

different anatomical orientations, also FLAIR, CISS/FIESTA, and diffusion imaging, should absolutely be acquired. For the midline sagittal view, it is especially vital to evaluate the presence or absence of vermian integrity and to clearly demonstrate the anatomy of the fourth ventricle and its relations to the tentorium (Patel and Barkovich, 2002). MRI can also diagnose associated supratentorial anomalies like corpus callosum agenesis or heterotopias.

Sedation or anesthesia may be needed in neonates to minimize motion artifacts. The protocols should be selected with consideration of the effect and the age of the patient, as well as the urgency of the clinical situation and the capability of the scanner, with the availability of motion-tolerant sequences on newer generation scanners allowing very rapid scanning in infants.

4.2.2. Cranial Ultrasound (Neurosonography)

In neonates with open fontanel, transfontanelle scanning provides a bedside, noninvasive method. It may be limited in its ability to evaluate the posterior fossa but can offer suggestions for hydrocephalus or cystic abnormalities. Using the mastoid fontanelle as an acoustic window improves visualization of the cerebellum and the fourth ventricle (Garcia-Heras and López-Sánchez, 2005).

4.2.3. CT

Within the setting of the diagnosis of CPFMs, CT is not the first line. Certain clinical settings make for the modality of choice… for the rapid diagnosis of hydrocephalus, calcifications, and skull base anomalies. It obviously carries a radiation burden that makes it less useful in pediatric neuroradiology but, for all that, its speeding ability and bone resolution enhance its utility in trauma or emergency settings (Sadler et al., 2020).

Table 5 Recommended MRI Sequences for Posterior Fossa Assessment

Sequence Type	Purpose	Notes
T1-weighted 3D (MPRAGE)	Structural anatomy, myelination	Best for midline and cerebellar morphology
T2-weighted (TSE/SSFSE)	CSF contrast, cystic lesions	Essential for delineating cysts and ventricles
FLAIR	Parenchymal signal abnormalities	Identifies gliosis, heterotopia
CISS/FIESTA	High-resolution cisternal anatomy	Superior for fourth ventricle, aqueduct, foramina
DWI/ADC	Ischemia, metabolic disorders	Useful in differentiating cytotoxic edema
SWI	Hemorrhage, venous anomalies	Optional, but useful in complex or syndromic cases

Sources: Patel and Barkovich (2002); Truwit (1991); Schaible and Goldstein (2014)

4.3. Practical Considerations for Radiologists

Imaging of CPFMs is not quite a mere technical matter; it requires some developmental awareness and a grasp of the sagittal-plane along with pattern recognition. It is, for instance, the fine details of the vermian morphology, tentorial elevation, and fourth ventricular shape that separate Blake's pouch cyst from Dandy–Walker malformation and mega cisterna magna (Calabrò et al., 2000; Azab et al., 2014).

In fetal MRI, one must take care to correlate findings with gestational age. A vermis appearing hypoplastic at week 19 may indeed still fall within the normal range of development (Klein et al., 2003). In contrast, absence of primary fissure or midline fusion after 22-24 weeks shall stand as pathological (Levine et al., 2008).

Moreover, the interpretation must be aligned with relevant clinical findings and family history and genetic work-up. A multidisciplinary approach involving the radiologist, pediatric neurologist, geneticist, and maternal-fetal medicine specialist would ensure an accurate diagnosis, preclude over diagnosis, and inform prognosis.

5. Imaging Features of Key Posterior Fossa Malformations

Accurate identification of congenital posterior fossa malformations (CPFMs) requires a systematic evaluation of the cerebellar vermis, fourth ventricle, posterior fossa volume, and nearby CSF spaces. It is, therefore, paramount that a high-resolution MRI be obtained, especially in the mid-sagittal plane, to differentiate between these anomalies, which are overlapping in appearance but are entirely different in clinical implication (Patel and Barkovich, 2002; Levine et al.,

2008). In this section of the chapter, we present and discuss with imaging details, differential pointers, and landmarks the most clinically relevant CPFMs (Figure 10).

5.1. Dandy–Walker Malformation (DWM)

Dandy-Walker malformation represents a serene classic and well-described malformation with three classical imaging features:

- A cystic dilation of the fourth ventricle,
- Complete or partial agenesis of the cerebellar vermis, and
- Enlargement of the posterior fossa, usually associated with elevation of the tentorium and torcula.

MRI commonly identifies a rotated vermian remnant, an upwardly displaced tentorium, and a high-riding torcular Herophili (Barkovich et al., 1989; Spennato et al., 2011). The T2-weighted mid-sagittal plane is the most diagnostic imaging plane with the axials showing cerebellar hemisphere separation due to the large fourth ventricular cyst.

Associated findings:

- Hydrocephalus (80–90% of cases)
- Agenesis of corpus callosum
- Polymicrogyria or cortical dysplasia (Golden et al., 1987)

Prognosis widely varies depending on associated anomalies and the extent of vermian agenesis (Klein et al., 2003).(Figure 4)

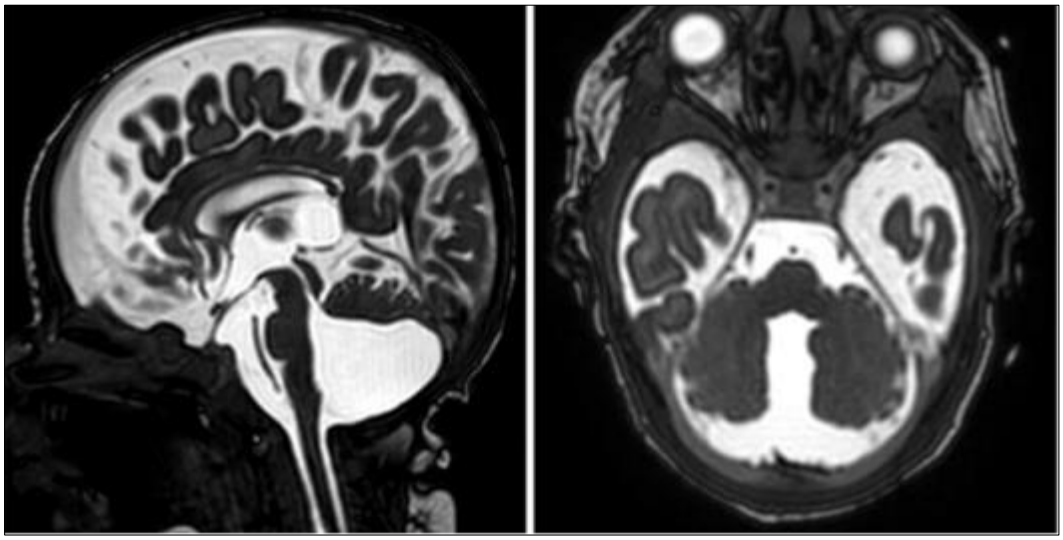


Figure 4 Sagittal and axial BFFE images show widened tegmento- vermian angle, elevated cerebellar vermis, enlarged fourth ventricle connecting to a large posterior fossa cyst. There is mild hypoplasia of the brainstem especially at the level of the basis pontis

5.2. Blake's Pouch Cyst (BPC)

BPC is often confused with DWM, but differs in embryologic origin and prognosis. It results from the non-perforation of the foramen of Magendie, allowing for the feature posterior bulging of Blake's pouch into the cisterna magna. The vermis, on the other hand, is intact and normally rotated, and importantly, there is no elevation of the tentorium (Calabrò et al., 2000; Azab et al., 2014).(Figure 5)

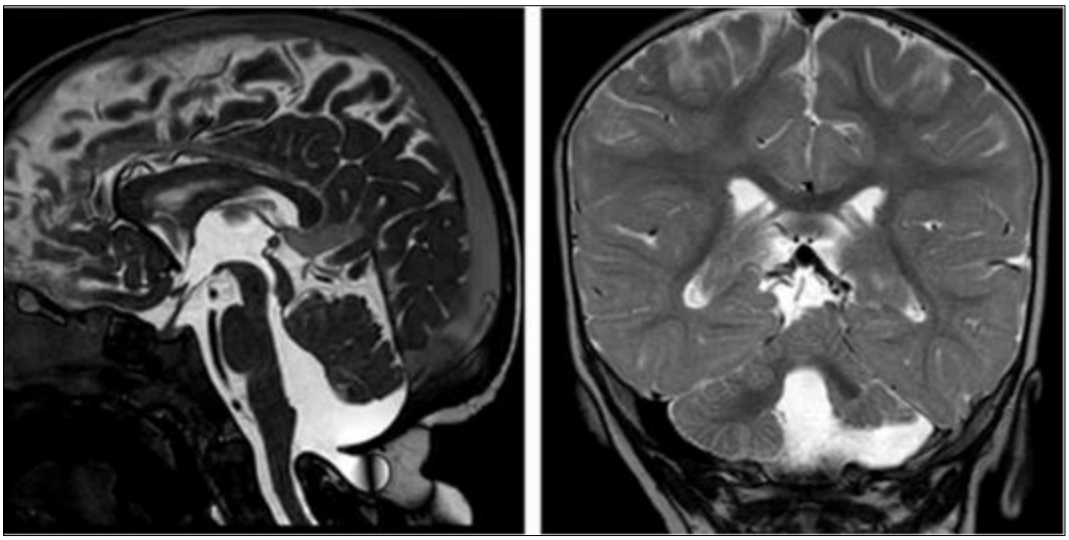


Figure 5 Sagittal BFFE and coronal T2W images show a posterior fossa fluid collection compatible with a Blake pouch cyst, which communicates with the fourth ventricle and elevates the normal-appearing inferior vermis, with increased tegmento-vermian angle. In addition,there is a small midline suboccipital meningocele, small dysmorphic left hemicerebellum and thick inferior tectum

5.3. Chiari Malformations

5.3.1. Chiari I Malformation

Defined by downward displacement of the cerebellar tonsils by more than 5 mm below the foramen magnum. MRI evidence includes crowding of the foramen magnum, T2 contrast may reveal syringomyelia (McClugage and Oakes, 2019) (Figure 6).

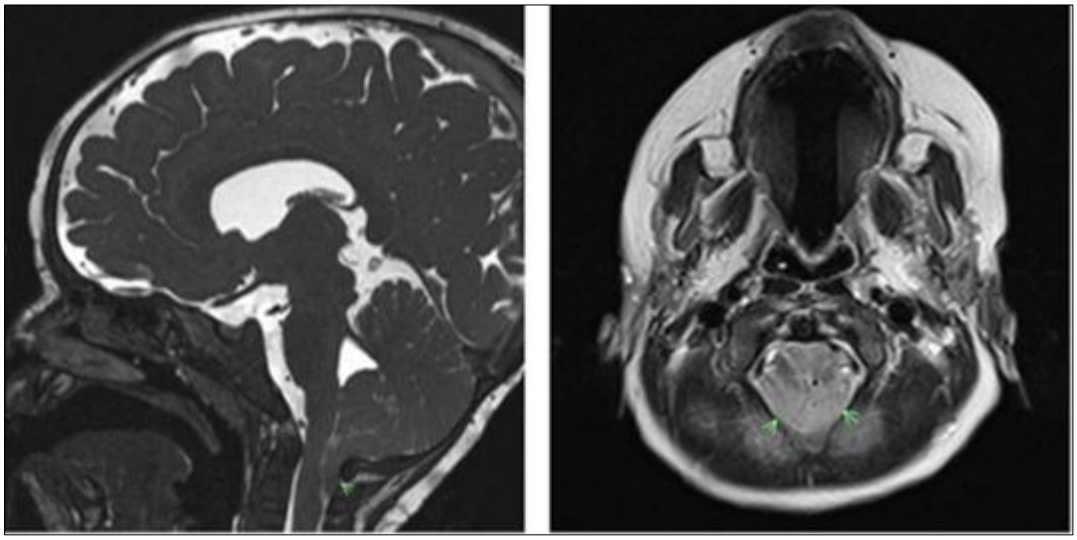


Figure 6 Sagittal BFFE and axial T2W images show extensive Chiari I malformation of the hindbrain with herniation of the cerebellar tonsils into the upper cervical spine causing crowding at the foramen magnum and mass effect on the cervicomedullary junction

5.3.2. Chiari II Malformation

Associated with myelomeningocele, hydrocephalus, and brainstem herniation. The fourth ventricle is elongated and low-lying, with tectal beaking (Spennato et al., 2011).(Figure 7)

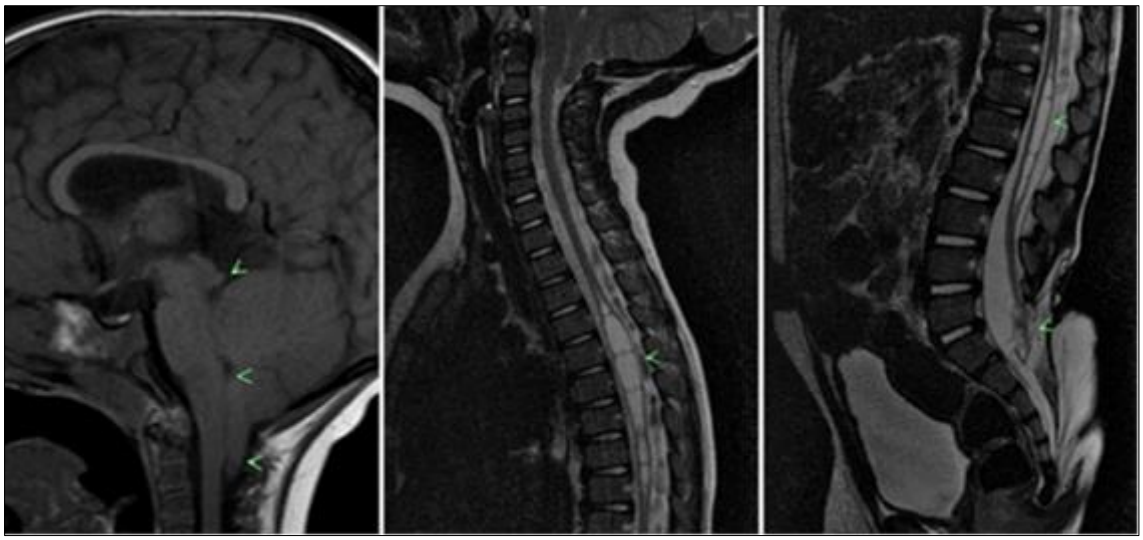


Figure 7 Sagittal T1W brain image shows Chiari II malformation features depicted by a small posterior fossa with low posterior attachment of the tentorium, caudally displaced slit-like fourth ventricle and medulla, cerebellar herniation and beaked tectum. Sagittal T2W spine images show multiseptated thoracic and lumbar syringohydromyelia, low lying cord with the distal end terminating at the dysraphic defect and post-surgical changes from prior myelomeningocele repair

5.3.3. Chiari III Malformation

The rarest form, where cerebellar structures herniate into a cervical or occipital encephalocele. Often incompatible with life.

5.4. Rhombencephalosynapsis

Defined by midline fusion of cerebellar hemispheres and absence of the vermis. MRI features suggest:

- Flattened posterior fossa anatomy
- Lack of midline fissures
- "Horseshoe" cerebellum appearance on axial imaging (Aldinger et al., 2018)

Commonly associated with Gómez–López–Hernández syndrome, aqueductal stenosis, and anomalies of the corpus callosum.

5.5. Arachnoid Cysts

Benign extra-axial CSF collections that may mimic posterior fossa cysts on MRI studies(Figure 8), which show:

- Smoothly contoured, sharply demarcated lucent fluid collection
- No communication with the ventricular system
- No enhancement, while lacking ependymal lining

They may press on adjacent structures, unlike BPC or MCM, and are non-communicating.

5.5.1. MRI clues

- Well-developed, non-hypoplastic vermis on a mid-sagittal view
- A cyst situated posterior to the fourth ventricle but communicating with it
- Normal-sized posterior fossa

Clinical notes:

- Often undergoes spontaneous postnatal resolution
- Rarely associated with neurodevelopmental delay (Azab et al., 2014)

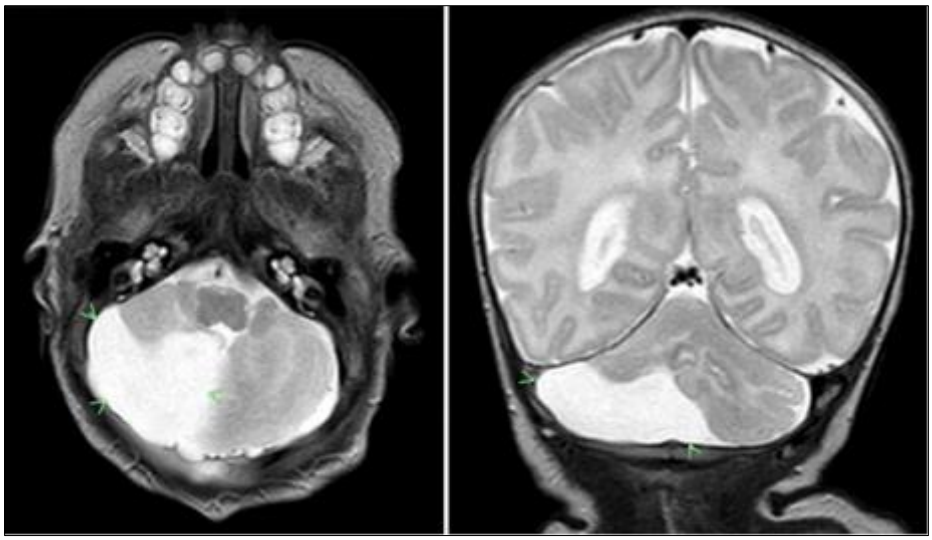


Figure 8 Axial and coronal T2W brain images show a cyst in the right aspect of the posterior fossa with mass effect on the right cerebellar hemisphere, fourth ventricle and cerebellar vermis. There is no torcular inversion. The fourth ventricle is normal in size and does not appear to communicate with the cyst. Findings consistent with arachnoid cyst

5.6. Mega Cisterna Magna (MCM)

MCM is defined as a cisterna magna >10 mm in diameter, with a normal vermis, cerebellar hemispheres, and fourth ventricle (Patel and Barkovich, 2002). This is most commonly an incidental finding, the implication being that it is probably a normal variant.(Figure 9)

5.6.1. MRI Findings

- Enlarged retrocerebellar fluid space
- Normal contour and position of the vermis
- No mass effect or compression of the cerebellar structures

To differentiate MCM from BPC, one needs to check communication with the fourth ventricle and vermis integrity, since MCM does not communicate with the fourth ventricle and is not lined by ependyma.

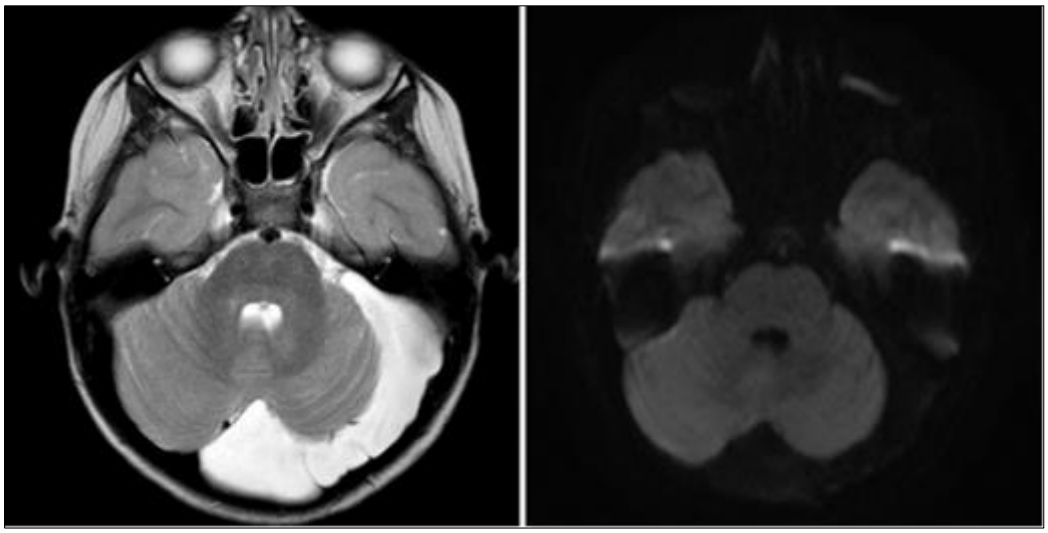


Figure 9 Axial T2W brain image and DWI image show prominent CSF space behind the left hemicerebellum that contains few incomplete folds. Normal vermis , fourth ventricle and torcula.No restricted diffusion. Findings consistent with Mega cisterna magna

5.7. Chiari Malformations

5.7.1. Chiari I Malformation

Defined by downward displacement of the cerebellar tonsils by more than 5 mm below the foramen magnum. MRI evidence includes crowding of the foramen magnum, T2 contrast may reveal syringomyelia (McClugage and Oakes, 2019).

5.7.2. Chiari II Malformation

Associated with myelomeningocele, hydrocephalus, and brainstem herniation. The fourth ventricle is elongated and low-lying, with tectal beaking (Spennato et al., 2011).

5.7.3. Chiari III Malformation

The rarest form, where cerebellar structures herniate into a cervical or occipital encephalocele. Often incompatible with life.

5.8. Rhombencephalosynapsis

Defined by midline fusion of cerebellar hemispheres and absence of the vermis. MRI features suggest:

- Flattened posterior fossa anatomy
- Lack of midline fissures
- "Horseshoe" cerebellum appearance on axial imaging (Aldinger et al., 2018)

Commonly associated with Gómez–López–Hernández syndrome, aqueductal stenosis, and anomalies of the corpus callosum.

5.9. Arachnoid Cysts

Benign extra-axial CSF collections that may mimic posterior fossa cysts on MRI studies, which show:

- Smoothly contoured, sharply demarcated lucent fluid collection
- No communication with the ventricular system
- No enhancement, while lacking ependymal lining

They may press on adjacent structures, unlike BPC or MCM, and are non-communicating.

Sources: Patel and Barkovich (2002); Schaible and Goldstein (2014); McClugage and Oakes (2019)

Figure 10 Imaging Features of Posterior Fossa Malformations

5.10. Practical Radiologic Strategy

To optimize interpretation:

- Always begin with the mid-sagittal T1/T2 view.
- Assess vermis morphology and tentorial location as well as fourth ventricle contour.
- So, check axial and coronal views for the configuration of cerebellar hemispheres and CSF.
- Corroborate with gestational age, in the case of fetal MRI.
- Record whether associated anomalies are present, such as supratentorial or extracranial abnormalities.

Timely and accurate diagnosis of these malformations is hence critical for changes in clinical management, be it surgical planning in Chiari I malformations or genetic counseling in cases of syndromic associations (Levine et al., 2008; Garcia-Heras and López-Sánchez, 2005).

6. Diagnostic challenges and pitfalls

Despite better prenatal and postnatal imaging methods, the diagnosis of congenital posterior fossa malformations (CPFMs) still remains subject to interpretation. Not only do many malformations share similar imaging appearances, but also many changes occur in the development of the posterior fossa, especially that of the cerebellar vermis, with gestation. Interpreting normal maturation as pathology or pathology as normal development can have grave implications, ranging from unnecessary termination to missed surgical intervention (Klein et al., 2003; Levine et al., 2008).

6.1. Common diagnostic pitfalls

Most commonly, errors observed during the radiologic evaluation for CPFMs are those related to timing misinterpretations, anatomical misidentifications, and equating one pathologic condition with another.

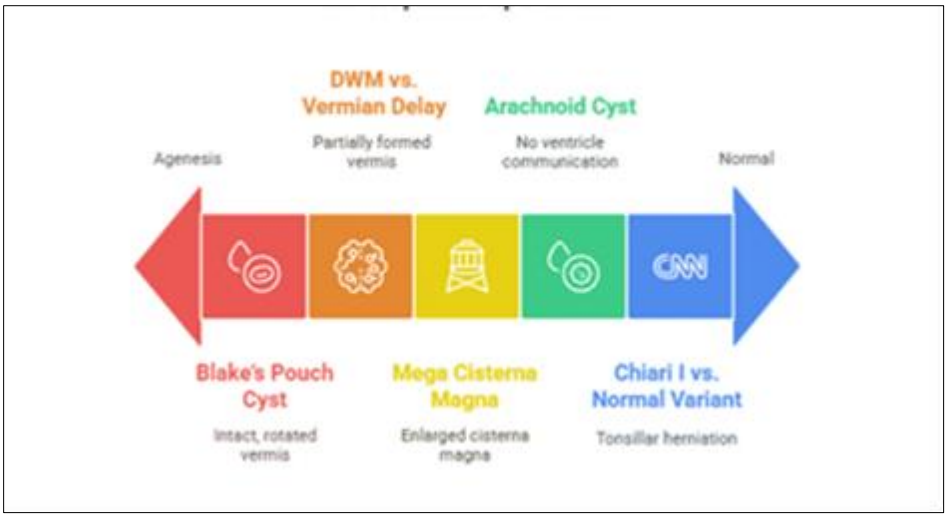
Table 6 Common Diagnostic Errors in Posterior Fossa Imaging

Pitfall Description	Example	Recommended Solution
Mistaking delayed vermian development for agenesis	Interpreting immature vermis before 20 weeks as DWM	Always correlate with gestational age (Levine et al., 2008)
Misdiagnosing Blake's pouch cyst as DWM	Misinterpreting normal vermis and mild cyst as severe pathology	Look for vermis rotation, tentorial position, and posterior fossa size
Overcalling mega cisterna magna	Enlarged CSF space reported as pathologic	Confirm normal vermis, no mass effect (Patel and Barkovich, 2002)
Missing rhombencephalosynapsis	Absent vermis mistaken for post-surgical change or artifact	Look for midline fusion of cerebellar hemispheres (Aldinger et al., 2018)
Ignoring sagittal plane	Relying on axial imaging alone	Always include mid-sagittal T1/T2 MRI views
Inadequate fetal MRI protocol	Motion artifacts or inappropriate sequencing	Use SSFSE, bSSFP, and acquire in three orthogonal planes

Sources: Levine et al. (2008); Aldinger et al. (2018); Patel and Barkovich (2002); Klein et al. (2003)

6.2. The "Grey Zones" of Diagnosis

Between the more discriminated diagnoses such as Chiari II malformation and the classic Dandy–Walker, there exist in-between presentations of the "grey zone" wherein differentiating one entity from another becomes highly subtle. The Dandy–Walker spectrum is quite prone to semantic confusion, especially whenever terms like Dandy–Walker variant or cerebellar hypoplasia are applied inconsistently (Calabrò et al., 2000).



Sources: Calabrò et al. (2000); Azab et al. (2014); Schaible and Goldstein (2014); McClugage and Oakes (2019)

Figure 11 Understanding posterior fossa malformations through vermis development spectrum

6.3. Strategies to Minimize Diagnostic Errors

To evade these pitfalls, posterolateral fossa interpretations have to undergo an approach systematic and layered:

- Start with gestational age: Vermian fusion begins at around week 9 but is not entirely completed until past 20–22 weeks. Early misdiagnosis often occurs when age is not taken into consideration (Levine et al., 2008).
- Use the midline sagittal plane as the reference: This is the most important single view to diagnose vermian abnormalities and also to assess the relationship of the fourth ventricle to the tentorium (Patel and Barkovich, 2002).
- Assess the fourth ventricle and cisterna magna for shape and communication: The answer often lies in this differential for a Blake's pouch cyst versus a DWM or an MCM.
- Consolidate axial and coronal views to search hemispheric symmetry: This is important for diagnosing rhombencephalosynapsis or cerebellar hypoplasia.
- Look for associated supratentorial anomalies: Agenesis of corpus callosum, aqueductal stenosis, and cortical malformations often point to a syndromic diagnosis, thus increasing chances of poor prognosis (Golden et al., 1987) (Figure 11) 12.

6.4. Multidisciplinary Review

Interpretation of CPFMs should not occur in isolation. Multidisciplinary review involving pediatric neurology, maternal-fetal medicine, genetics, and neurosurgery ensures that all potential diagnoses are considered and prevents premature conclusions being drawn on the basis of imaging alone (Sadler et al., 2020).

From the standpoint of radiomics, it is also promising that machine learning algorithms can increase diagnostic certainty in the evaluation of the posterior fossa. Early studies describe automated algorithms that can measure vermian angle, assess tentorial slope, and even classify the fluid collections of the posterior fossa with high accuracy (Qi et al., 2025).

7. Clinical Correlation and Management Implications

Diagnosing congenital posterior fossa malformations is not the end of radiologic work; it is the beginning of a critical cascade that will influence clinical management, prognosis, and often the emotional and ethical decisions surrounding neonatal care or pregnancy continuation. The imaging aspect, therefore, has much more than a descriptive role: it assumes central roles in risk stratification, therapeutic planning, and communication across disciplines (Klein et al., 2003; Levine et al., 2008).

Precisely characterizing a malformation on imaging, whether it be a benign variant like mega cisterna magna or one of the more complex anomalies such as Dandy–Walker malformation (DWM), can mean all the difference for a child. This section relates radiologic features with clinical consequences, ordered by the type of malformation.

7.1. Prognostic Importance of Imaging Findings

The greatest imaging-based indicators of neurologic outcome are; degrees of vermis development, presence or absence of hydrocephalus, tentorial elevation, and associated supratentorial anomalies (Figure 12). For example:

- Blake's pouch cyst has a good prognosis if isolated, with the vast majority of the children having a normal development (Azab et al., 2014).
- On the other hand, DWM combined with supratentorial anomalies such as callosal agenesis or cortical malformations carries a much worse prognosis (Golden et al., 1987).
- When symptomatic, Chiari I malformations often need to be watched carefully for signs of scoliosis, syringomyelia, or headache and for their need for surgical decompression (McClugage and Oakes, 2019).
- Imaging can also diagnose subtle brainstem compressions of utmost importance, which, in severe forms, have been correlated with autonomic dysfunction and respiratory arrest (Spennato et al., 2011).

Table 7 Summary of Clinical Relevance by Malformation Type

Malformation	Management Strategy	Prognosis (if isolated)	Imaging-Based Red Flags
Dandy–Walker Malformation	Neurosurgical shunting (if hydrocephalus), early intervention	Variable; worse if supratentorial anomalies present	Tentorial elevation, enlarged posterior fossa
Blake's Pouch Cyst	Observation or VP shunt if symptomatic	Excellent	None if vermis and tentorium are normal
Mega Cisterna Magna	None (incidental finding)	Excellent	Mistaken for BPC or arachnoid cyst
Rhombencephalosynapsis	Supportive, developmental therapy	Poor to moderate	Absent vermis, fused hemispheres
Chiari I	Surgical decompression if symptomatic	Good post-decompression	Tonsillar herniation >5 mm, syrinx
Chiari II	Shunt, repair of neural tube defect	Variable; often poor due to complexity	Tectal beaking, small posterior fossa
Arachnoid Cyst	Surgery if symptomatic or growing	Excellent if treated	Mass effect on brainstem or cerebellum

Sources: Klein et al. (2003); Spennato et al. (2011); Azab et al. (2014); McClugage and Oakes (2019)

7.2. Relevance in Surgical Planning

The neuroradiologist has a pivotal role in ensuring the proper neurosurgical management of patients by:

- Diagnosing hydrocephalus that requires ventriculoperitoneal (VP) shunting.
- Evaluating syringomyelia in Chiari I that may raise the necessity for posterior fossa decompression.
- Differentiating BPC, which generally resolves spontaneously, from DWM, which might require surgical drainage.

Imaging should report:

- The degree of tonsillar descent in Chiari I
- The fourth ventricular size and outflow in DWM/BPC
- Any compression of the brainstem or aqueduct

This influences the timing and type of neurosurgical intervention (Spennato et al., 2011).

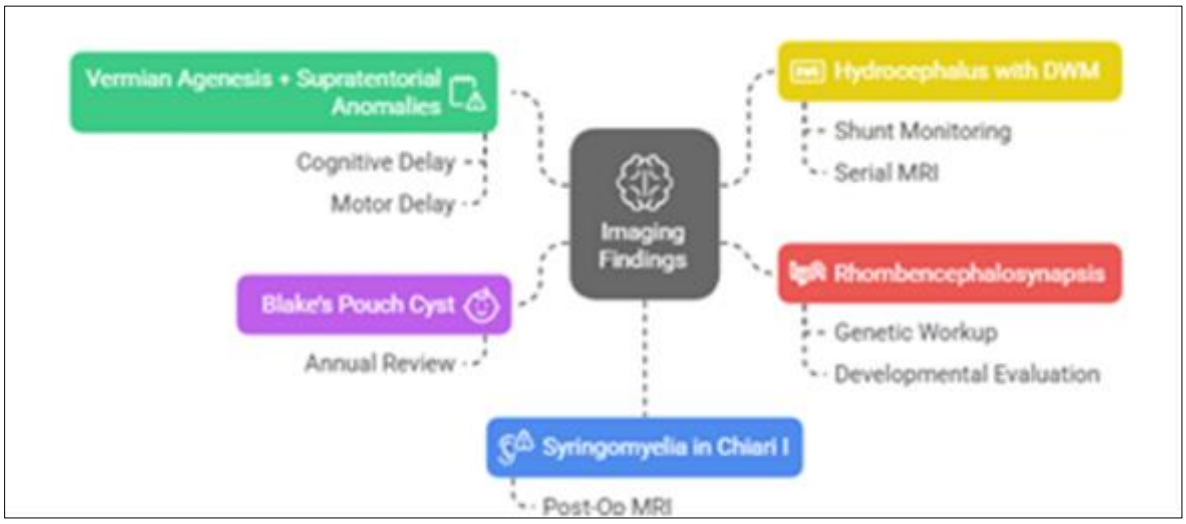
7.3. Counseling and Prenatal Decision-Making

In the prenatal setting, accurate characterization of CPFMs provides critical data for genetic counseling, prognostic forecasting, and parental decision-making. Fetal MRI findings are often a turning point for families weighing whether to continue a pregnancy, initiate in utero therapy, or plan for postnatal intervention (Levine et al., 2008).

Important considerations include:

- Isolated Blake's pouch cyst: Usually compatible with normal neurodevelopment.
- DWM with cortical or callosal abnormalities: Higher risk of intellectual disability, seizures, or motor delay.
- Rhombencephalosynapsis: Frequently syndromic and associated with poor outcome.

Counseling should involve the radiologist, fetal medicine specialist, neurologist, and geneticist, especially if anomalies fall within syndromes like Gómez–López–Hernández or Walker–Warburg (Aldinger et al., 2018; Garcia-Heras and López-Sánchez, 2005).



Sources: Golden et al. (1987); Aldinger et al. (2018); Spennato et al. (2011)

Figure 12 Imaging Findings and Clinical Implications

7.4. An Expanding Role of Radiology

With the growth of precision medicine, radiologists will engage more and more in risk prediction modeling using, for example, AI-driven radiomics, volumetric cerebellar analysis, and automated vermian scoring systems (Qi et al., 2025). These technologies will be able to:

- Measure deviation from normal structures beyond what the human eye can perceive
- Help classify cases during very early fetal imaging
- Predict neurodevelopmental outcomes just on the imaging features

Bringing these tools to what is today considered a standard radiologic workflow will allow radiology to transcend pattern recognition to quantitative, predictive neurodevelopmental triage.

8. Conclusion

Congenital posterior fossa malformations stand as an incredibly diagnostic and very clinically relevant set of anomalies that even challenge some of an expert radiologist. Having a sound knowledge of embryologic development with advanced imaging protocols coupled with evolving classifications allows the radiologist to weigh in with invaluable prognostic, counseling, and management insights.

In the great differentiation between Dandy–Walker malformation, Blake's pouch cyst, and mega cisterna magna with its syndromic implications in rhombencephalosynapsis and Chiari malformations, this review emphasizes the need for systematic sagittal-based imaging interpretation aided by a gestational age examination and assessment of multiplanar

indices. Diagnosing CPFMs is not just a question of technical expertise; it requires developmental insight, multidisciplinary integration, and clinical foresight.

The evolution from descriptive radiology to integrated, predictive neuroimaging is well underway. Orthogonal fetal MRI has mostly bypassed prenatal investigation, whereas postnatal MRI is still the reference standard for structural evaluation. Concurrently, machine learning and radiomics tools are now beginning to support interpretation, with quantified vermian assessment and cyst segmentation in their line of sight, as well as long-term developmental risk prediction.

The radiologist, therefore, in CPFMs, can go beyond the usual image acquisition and reporting. It includes bridging embryology and imaging, pattern recognition to pathology, and providing clarity in an area where uncertainty can change one's life irrevocably. Hence using a structured approach aided by ongoing innovation and multidisciplinary teamwork, imaging stands at the cornerstone of translating accuracy in diagnosis into improved outcome for affected children and their families.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Barkovich, A. J., Kjos, B. O., Norman, D., and Edwards, M. S. (1989). Revised classification of posterior fossa cysts and cystlike malformations based on multiplanar MR imaging. American Journal of Roentgenology, 153(2), 355–365.

[2] Kollias, S. S., Ball, W. S., and Prenger, E. C. (1993). Cystic malformations of the posterior fossa: differential diagnosis clarified through embryologic analysis. Radiographics, 13(6), 1213–1235.

[3] Spennato, P., Mirone, G., Buonocore, M. C., and Ruggiero, C. (2011). Hydrocephalus in Dandy–Walker malformation. Child's Nervous System, 27(10), 1671–1680.

[4] Calabrò, F., Arcuri, T., and Jinkins, J. R. (2000). Blake's pouch cyst: an entity within the Dandy–Walker continuum. Neuroradiology, 42(4), 315–322.

[5] Klein, O., PierreKahn, A., Boddaert, N., Parisot, D., and Brunelle, F. (2003). Dandy–Walker malformation: prenatal diagnosis and prognosis. Child's Nervous System, 19(7–8), 445–451.

[6] Shimony, J. S., Strelets, V. B., and Pai Panandiker, A. S. (2011). Diagnostic imaging of posterior fossa anomalies in the fetus and neonate: Part I—Ultrasound findings. Clinical Imaging, 35(5), 367–374.

[7] TortoriDonati, P., and Norman, M. G. (2011). Posterior Fossa Malformations. In Congenital Malformations of the Brain: Pathologic, Embryologic, Clinical, Radiologic and Genetic Aspects (pp. 450–480). Springer.

[8] Patel, S., and Barkovich, A. J. (2002). Analysis and classification of cerebellar malformations. American Journal of Neuroradiology, 23(7), 1074–1087.

[9] Silva, C. et al. (2009). Posterior fossa morphometry in symptomatic pediatric and adult Chiari I malformation. Journal of Clinical Neuroscience, 16(11), 1475–1480.

[10] McClugage, S. G., and Oakes, W. J. (2019). The Chiari I malformation: JNSPG 75th Anniversary Invited Review Article. Journal of Neurosurgery: Pediatrics, 23(3), 289–301.

[11] Patel, S., and Barkovich, A. J. (2002). et al. (see Turn0search25)

[12] Taggart, J. K., and Walker, A. E. (1942). Congenital atresia of the foramens of Luschka and Magendie. Archives of Neurology and Psychiatry.

[13] Dandy, W. E., and Blackfan, K. D. (1914). An experimental, clinical and pathological study. American Journal of Diseases of Children.

[14] Sutton, J. B. (1886). The lateral recesses of the fourth ventricle. Brain, 9(4), 365–377.

[15] Ecker, J. et al. (2007). Dandy–Walker malformation: antenatal sonographic diagnosis. Journal of Pediatric Radiology.

[16] Fernandez, M., and Cohen, R. (1996). PHACE syndrome: brain anomalies and hemangiomas. Archives of Dermatology, 132(3), 252–256.

[17] Metry, D. W., et al. (1993). The many faces of PHACE syndrome. Journal of Pediatrics, 122(5 Pt 1), 699–703. en.wikipedia.org

[18] Azab, W. A., Shohoud, S. A., Elmansoury, T. M., Salaheddin, W., and Nasim, K. (2014). Blake's pouch cyst. Surgical Neurology International, 5, 174. en.wikipedia.org+1emedicine.medscape.com+1

[19] Ruff, C. et al. (2021). Diagnosis and treatment of Chiari malformation ... Neurological Sciences. en.wikipedia.org

[20] Cotes, C. (2015). Congenital basis of posterior fossa anomalies. Neuroradiology Journal, 28(3), 207–224. ajnr.org+15en.wikipedia.org+15pmc.ncbi.nlm.nih.gov+15

[21] Truwit, C. L. (1991). MR imaging of rhombencephalosynapsis: report of three cases. AJNR, 12(5), 1009–1015. en.wikipedia.org

[22] Aldinger, K. A. et al. (2018). Rhombencephalosynapsis and MN1 syndrome. American Journal of Medical Genetics C, 178(C4), 482–490. en.wikipedia.org

[23] GarciaHeras, J., and LópezSánchez, M. (2005). Prenatal MRI in GomezLopezHernandez syndrome. American Journal of Medical Genetics Part A, 137A(2), 98–102. en.wikipedia.org

[24] Sadler, B., et al. (2020). Prevalence and impact of underlying diagnosis on Chiari I malformation. Pediatric Neurology, 102, 35–43. en.wikipedia.org

[25] Kuether, T. A., and Piatt, J. H. (1998). Chiari malformation associated with rickets. Neurosurgery, 43(1), 168–171. en.wikipedia.org

[26] Patel, S., and Barkovich, A. J. (2002). Normal and abnormal anatomy of the cerebellar vermis ... Birth Defects Research. emedicine.medscape.com+4en.wikipedia.org+4en.wikipedia.org+4

[27] Forzano, F., Mansour, S., Ierullo, A., Homfray, T., and Thilaganathan, B. (2007). Posterior fossa malformation in fetuses. Prenatal Diagnosis, 27(9), 815–820. en.wikipedia.org

[28] Spennato, P. et al. (2008). The Dandy–Walker variant: case series ... Journal of Neurosurgery: Pediatrics, 1(3), 229–236. ajog.org+4en.wikipedia.org+4emedicine.medscape.com+4

[29] Hammond, C. J., Chitnavis, B., Penny, C. C., and Strong, A. J. (2002). Dandy–Walker complex and syringomyelia in an adult. Neurosurgery, 50(2), 440–444. en.wikipedia.org

[30] Golden, J. A., Rorke, L. B., and Bruce, D. A. (1987). Dandy–Walker syndrome and associated anomalies. Pediatric Neurosurgery, 13(6), 268–275. en.wikipedia.org

[31] Bindal, A. K., Storrs, B. B., and McLone, D. G. (1990). Management of the Dandy–Walker syndrome. Pediatric Neurosurgery, 16(1), 17–24. en.wikipedia.org

[32] Coulon, O., and Mazoyer, B. M. (2011). Evaluation of posterior fossa biometric measurements on fetal MRI. AJNR, 42(9), 1716–1722. researchgate.net+7ajnr.org+7clinicalimaging.org+7

[33] Levine, D., et al. (2008). How accurately does fetal imaging identify posterior fossa malformations? AJR American Journal of Roentgenology, 189(3), 706–715. onlinelibrary.wiley.com+2ajronline.org+2pubs.rsna.org+2

[34] Schaible, A., and Goldstein, R. (2014). Imaging spectrum of posterior fossa anomalies on fetal MRI. Radiographics, 34(2), 691–706. pmc.ncbi.nlm.nih.gov

[35] GarciaHeras, J., and LopezSanchez, M. (2005). See #23

[36] Sajjad, Z., et al. (2024). Review of prominent retrocerebellar CSF space in children. Clinical Radiology, 79(2), e1–e9. clinicalradiologyonline.net

[37] Qi, Y., et al. (2025). Deep LearningAssisted Detection of Fetal CNS Anomalies via Ultrasound Imaging. ArXiv Preprint. arxiv.org

[38] Lumenta, C. B., and Skotarczak, U. (1995). Longterm followup in 233 patients with congenital hydrocephalus. Child's Nervous System, 11(2), 112–118. en.wikipedia.org

[39] Spennato, P., et al. (2011). Criteria for diagnosing Dandy–Walker malformation. Child's Nervous System, 27(10), 1657–1670. en.wikipedia.org+7en.wikipedia.org+7emedicine.medscape.com+7

[40] Bindal, A. K., Storrs, B. B., and McLone, D. G. (1990).