Midsagittal images of the brain provide a wealth of anatomic information and may show abnormalities that are pathognomonic for particular diagnoses. Using an anatomy-based approach, the authors identify pertinent anatomic structures to serve as a checklist when evaluating these structures. Subregions evaluated include the corpus callosum, pituitary gland and sellar region, pineal gland and pineal region, brainstem, and cerebellum. The authors present 25 conditions with characteristic identifiable abnormalities at midsagittal imaging. Midsagittal views from multiple imaging modalities are shown, including computed tomography, ultrasonography, and magnetic resonance (MR) imaging. Standard MR imaging sequences are shown, as well as fetal MR and sagittal diffusion-weighted images. To demonstrate these conditions, fetal, neonatal, childhood, adolescent, and young adulthood images are reviewed. The differentiation of normal variants is guided by the understanding of anatomy and pathology. When a specific diagnosis is not possible, the authors present information to evaluate differential considerations and discuss when follow-up imaging may be indicated. The authors hope each case will clarify a pertinent differential diagnosis, appropriately guide patient management, and improve understanding of normal anatomy and identification of pathologic entities. It is in these hopes that the authors have presented a checklist of pertinent anatomy and pathologic entities that can build on existing search patterns. Improved confidence and accuracy in the evaluation of midsagittal images will benefit physicians and patients.

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Introduction

The midsagittal image is an information-rich image within multiplanar imaging sets of the brain. On this image, many diagnoses can be considered, made, and confirmed by the radiologist. Effective extraction of maximal information from these images benefits from knowledge of normal anatomic features. A large number of anatomic structures and spaces can be identified on midsagittal images of the brain (Table), and the majority are best seen at magnetic resonance (MR) imaging; however, many can be seen at computed tomography (CT) and, to a lesser extent, at ultrasonography (US) of the fetal and neonatal brain.

With knowledge of the normal structures of the brain, we present 25 conditions with characteristic identifiable abnormalities at midsagittal imaging. This includes pathologic conditions as well as normal variants. These are grouped into corpus callosum–related entities, sellar region entities, cerebellar entities, pineal region entities, vascular entities, and several unclassified entities. The clinical situation for these entities varies considerably and includes congenital, acquired, and neoplastic causes, some of which are incidental findings and others with severe consequences. Some of these findings may be seen in
patients in utero through adulthood. This anatomy-based taxonomy follows successful schemes in other anatomic regions (1). Through this, we hope there will be improved understanding of the normal anatomy and improved identification of pathologic entities.

Normal Anatomy

Corpus Callosum, Anterior Commissure, and Fornices
The corpus callosum is the dominant forebrain commissure in placental mammals (2). The corpus callosum can be subdivided into the rostrum, genu, body, isthmus, and splenium (Fig 1). The lamina rostralis is a membrane that spans between the rostrum of the corpus callosum and the anterior commissure (3). The fornix arises from the hippocampal fimbria, with the fornical crura gradually joining at the midline to form the body of the fornix. The fornical bodies course anteriorly along the inferior margin of the isthmus and the body of the corpus callosum before extending inferiorly as the fornical columns, which are along the posterior margin of the anterior commissure at the midline, and eventually reach the mammillary bodies.

Sella Turcica and Suprasellar Region: Central and Anterior Skull Base
The sella turcica is a saddle-shaped concavity in the basisphenoid, within which is found the pituitary gland. The pituitary gland is subdivided into the adenohypophysis and neurohypophysis, and it is connected through the pituitary infundibulum to the hypothalamus. Above the pituitary gland is the suprasellar cistern, which contains the optic chiasm.

The floor of the anterior cranial fossa is composed of the superior margin of the sphenoid bone, including the planum sphenoidale, the ethmoid bone, and cribriform plate. A vertical midline projection from the anterior cribriform plate is known as the crista galli. The basisphenoid is in contact with the basiocciput. When the intervening spheno-occipital synchondrosis fuses, these two structures form the clivus. The inferior tip of the basiocciput is known as the basion, serving as the anterior margin of the foramen magnum.

Third Ventricle
The lamina terminalis and optic chiasma form the anterior margin of the third ventricle. At the interface with the optic chiasm and pituitary infundibulum are the chiasmatic and infundibular recesses of the third ventricle, respectively. The floor of the third ventricle spans from the pituitary infundibulum to the mammillary bodies and includes a part of the hypothalamus known as the tuber cinereum. Along the posterior boundary of the third ventricle is the pineal gland. A tiny focal indentation in the third ventricle is seen at the level of the pineal gland, known as the pineal recess of the third ventricle. In addition, there is a suprapineal recess that is variable in size.

The third ventricle communicates with the fourth ventricle through the aqueduct of Sylvius, which courses between the tectum and tegmentum of the mesencephalon. The posterior commissure is located along the superior margin of the third ventricular interface with the aqueduct of Sylvius and along the inferior margin of the suprapineal recess of the third ventricle. Within the third ventricle is the massa intermedia, also known as the interthalamic adhesion, which is a variable structure not found in all individuals.

Brainstem, Cerebellum, and Fourth Ventricle
The posterior part of the midbrain is the tectum, also known as the tectal plate or quadrigeminal plate. The “quad” of quadrigeminal refers to the four colliculi contained within the tectum, which includes two superior colliculi and two inferior colliculi. Caudal to the midbrain is the pons, which serves as the anterior boundary of the fourth ventricle. The posterior boundary of the fourth ventricle is formed by the cerebellar vermis. The normal cerebellar vermis has the shape of the well-known video game character Pac-Man, as the superior aspect of the posterior boundary of the fourth ventricle (known as the superior medullary velum) and the inferior aspect of the posterior boundary of the fourth ventricle (known as the inferior medullary velum) come

TEACHING POINTS
- DAI can occur in the setting of normal head CT and is best depicted on susceptibility- and diffusion-weighted images. Rotational acceleration-deceleration forces may be a particular risk factor for DAI.
- An ectopic neurohypophysis is often associated with adenohypophysial dysfunction, most commonly a growth hormone deficiency.
- In a Chiari II malformation, there is caudal cerebellar extension involving the tonsils and the vermis, as compared to the cerebellar tonsillar ectopia in a Chiari I malformation.
- Mega cisterna magna is a normal variant and is associated with craniocervical junction ligamentous injury.
**Anatomic Structures Identifiable on Midsagittal Images of the Brain**

<table>
<thead>
<tr>
<th>Category</th>
<th>Anatomic Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corpus callosum</td>
<td>1 = rostrum, 2 = genu, 3 = body, 4 = isthmus, 5 = splenium</td>
</tr>
<tr>
<td>Suprasellar</td>
<td>6 = lamina rostralis, 7 = lamina terminalis, 8 = optic chiasm</td>
</tr>
<tr>
<td>Third ventricle</td>
<td>9 = chiasmatic recess of third ventricle, 10 = infundibular recess of third ventricle, 11 = pineal recess of third ventricle, 12 = suprapineal recess of third ventricle, 13 = floor of third ventricle/tuber cinereum</td>
</tr>
<tr>
<td>Pituitary</td>
<td>14 = pituitary infundibulum, 15 = adenohypophysis, 16 = neurohypophysis</td>
</tr>
<tr>
<td>Anterior skull base</td>
<td>17 = crista galli, 18 = planum sphenoidale, 19 = cribiform plate, 20 = chiasmatic groove, 21 = tuberculum sellae, 22 = dorsum sellae, 23 = basiophyseal, 24 = spheno-occipital synchondrosis, 25 = basioccipl, 26 = basion</td>
</tr>
<tr>
<td>Other bones</td>
<td>27 = opisthion, 28 = frontal bone, 29 = sagittal suture, 30 = occipital squama, 31 = internal occipital protuberance, 32 = external occipital protuberance</td>
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<tr>
<td>Veins</td>
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</tr>
<tr>
<td>Arteries</td>
<td>39 = basilar artery, 40 = anterior cerebral arteries, 41 = pericallosal arteries, 42 = callosomarginal arteries</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>43 = pineal gland, 44 = posterior commissure, 45 = massa intermedia, 46 = anterior commissure, 47 = forniceal body, 48 = forniceal column</td>
</tr>
<tr>
<td>Midbrain/brainstem</td>
<td>49 = mamillary body, 50 = mesencephalon, 51 = quadrigeminal plate, 52 = superior colliculi, 53 = inferior colliculi, 54 = pons, 55 = medulla, 56 = obex, 57 = floor of the fourth ventricle, 58 = aqueduct of Sylvius, 59 = pontomedullary sulcus</td>
</tr>
<tr>
<td>CSF spaces</td>
<td>60 = interpeduncular fossa, 61 = suprasellar cistern, 62 = preoptic cistern, 63 = quadrigeminal cistern, 64 = fourth ventricle, 65 = cisterna magna</td>
</tr>
<tr>
<td>Cerebrum</td>
<td>66 = cingulate gyrus, 67 = marginal sulcus, 68 = parieto-occipital sulcus, 69 = calcarine fissure, 70 = cuneus, 71 = precuneus, 72 = lingual gyrus, 73 = paracentral lobule</td>
</tr>
<tr>
<td>Sinonasal</td>
<td>74 = sphenoid sinuses, 75 = ethmoid sinuses, 76 = frontal sinuses</td>
</tr>
<tr>
<td>Dura/ligaments</td>
<td>77 = tentorium cerebelli, 78 = tectorial membrane, 79 = nuchal ligament, 80 = posterior atlanto-occipital ligament</td>
</tr>
<tr>
<td>Cerebellum</td>
<td>81 = cerebellar vermis, 82 = superior medullary velum, 83 = inferior medullary velum, 84 = fastigium, 85 = primary fissure of the vermis, 86 = secondary fissure of the vermis, 87 = tonsil</td>
</tr>
</tbody>
</table>

**Note.**—CSF = cerebrospinal fluid.

Together at the fastigium. Caudal to the pons is the medulla oblongata, delineated by the pontomedullary sulcus.

**Arterial Structures**

The anterior cerebral arteries reach the midline at the A1-A2 junction, where the anterior communicating artery is found. The A2 and A3 segments of the anterior cerebral artery course to the anterior margin of the genu of the corpus callosum. The vessels then course along the superior margin of the corpus callosum, known as the pericallosal artery, and branch along the superior margin of the cingulate gyrus, known as the callosomarginal arteries. The basilar artery courses superiorly in the preoptic cistern, between the pons and the clivus.

**Venous Structures**

The superior sagittal sinus courses along the dural interface between the falk cerebri and the calvaria, posteriorly joining the straight sinus at the torcula. The straight sinus is formed by the junction of the vein of Galen and the inferior sagittal sinus. The vein of Galen is formed by the junction of the two internal cerebral veins, the two basal veins of Rosenthal (not seen on midsagittal images), and the superior vermian vein.

**Skull Anatomy**

The anterior covering of the cerebral hemispheres is provided by the frontal bone. Overlying the superior margin of the posterior frontal lobes and parietal lobes is the sagittal suture, which is the junction between the two parietal bones. Posterior to the parietal bones is the occipital bone, which is composed of the posterior margin of the occipital lobes and posterior fossa. The posterior inferior margin of the occipital bone is known as the opisthion, which is at the posterior margin of the foramen magnum. The internal occipital protuberance is a focal contour change in the inner table of the occipital bone at the location of the torcula. The external occipital protuberance is a focal contour change in the outer table of the occipital bone at the level of the insertion of the nuchal ligament.
Figure 1. Normal midsagittal anatomy of the brain. The figure keys are identified in the Table. (a, b) Non-enhanced (a) and contrast material–enhanced (b) sagittal T1-weighted MR images show a normal brain. (c) Sagittal T1-weighted MR image shows the central structures of the brain. (d) Sagittal T1-weighted MR image shows the posterior fossa structures. (e) Sagittal constructive interference in the steady state (CISS) MR image shows the third and fourth ventricles.
Figure 2. ACC. (a) Sagittal T1-weighted MR image shows absence of the corpus callosum in a 6-year-old boy with developmental delay. The anterior commissure (arrow) is present. Note the gyri (arrowheads) in the parasagittal aspects of the parietal lobe and posterior frontal lobe, which radiate from the third ventricle. This has been referred to as a “sunburst” pattern. (b) Sagittal two-dimensional fast imaging employing steady-state acquisition MR image of the fetal brain shows radiating parasagittal gyri (arrowheads) in a different patient in the setting of ACC.

Cerebral Hemispheres
The occipital lobe is separated from the parietal lobe by the parieto-occipital sulcus. Within the occipital lobe is the horizontally oriented calcarine fissure. Inferior to the calcarine fissure is the lingual gyrus. Between the parieto-occipital sulcus and the calcarine fissure is the wedge-shaped cuneus. Anterior to the parieto-occipital fissure is the precuneus, which extends to the level of the marginal sulcus. Anterior to the marginal sulcus is the paracentral lobule. The marginal sulcus reaches the superior aspect of the interhemispheric fissure along the posterior margin of the postcentral gyrus.

Cerebrospinal Fluid Spaces
Anterior to the pons is the prepontine cistern, and anterior to the medulla is the premedullary cistern. At the boundary between the pons and the medulla oblongata is the pontomedullary sulcus. Anteriorly, between the pons and mesencephalon, is the interpeduncular fossa. Posterior to the quadrigeminal plate and pineal gland is the quadrigeminal cistern, which posteriorly is in continuity with the superior cerebellar cistern. Inferior to the isthmus of the corpus callosum and posterior fornical bodies is the velum interpositum. Inferior to the cerebellar vermis is the cisterna magna. Superior to the sella turcica is the suprasellar cistern.

Corpus Callosum–related Entities
Agenesis of the Corpus Callosum
When the corpus callosum does not develop, which is known as agenesis of the corpus callosum (ACC) (Fig 2), there is also nondevelopment of the adjacent cingulate gyrus. The absence of the cingulate gyrus allows midsagittal gyri to extend from the margin of the ventricular system to the cerebral surface near the vertex in a radiating pattern. The anterior commissure will usually be seen in ACC. The white matter fibers, which would normally have contributed to the corpus callosum, can often be identified off-midline as the bundles of Probst, which course along the medial margin of the body of the lateral ventricles.

ACC can be associated with an interhemispheric arachnoid cyst and/or cystic meningeal dysplasia. Aicardi syndrome is a condition involving ACC with characteristic retinal abnormalities (chorioretinal lacunae), which is found only in patients with two X chromosomes. ACC can also be a feature of some tubulinopathies, conditions related to a mutation in one or more of the seven known genes that encode for the protein tubulin. These gene mutations have several associated types of brain malformations, an association recognized only recently (4).

Corpus Callosum Lipoma
During the development of the corpus callosum, there may be persistence of the meninx primitiva, a menenchymal element involved in neural development. These remnant cells may differentiate into adipose tissue and result in a lipoma along the dorsum of the corpus callosum (Fig 3). The morphology of a corpus callosum lipoma can be curvilinear or nodular, and it may be associated with a malformed corpus callosum. The callosal lipoma demonstrates T1
shortening. Fat-suppressed imaging can help confirm the fatty nature. This is an incidental finding that does not require treatment. Focal areas of ossification can sometimes be seen with an osteolipoma of the corpus callosum.

**Diffuse Axonal Injury**

Diffuse axonal injury (DAI), also known as a *shear injury*, represents an acceleration-deceleration injury to the brain, which can result in petechial hemorrhages and/or focal transection of white matter fibers. Transection of white matter fibers most commonly occurs in the region of the gray-white matter junction, as well as within the corpus callosum (Fig 4). DAI can occur in the setting of normal head CT and is best depicted on susceptibility- and diffusion-weighted images. Rotational acceleration-deceleration forces may be a particular risk factor for DAI (5–8). Susceptibility-weighted imaging is an important addition to routine imaging protocols in patients with trauma, especially with a suspected DAI.

**Transient Splenial Lesion**

A midsplenial area of restricted water diffusion can be a transient finding on a postictal basis, as well as after viral infections such as influenza (9) (Fig 5). Identifying this as a transient finding is a diagnosis of exclusion; if there is clinical uncertainty, follow-up MR imaging studies to document resolution and a lack of resultant volume loss or gliosis may help. However, in the setting of trauma, splenial diffusion restriction is more likely to represent a shear injury.
Sellar Region Entities

Ectopic Neurohypophysis

The neurohypophysis represents the distal axons of cells residing in the supraoptic and paraventricular nuclei of the hypothalamus. These nuclei create the peptide hormones vasopressin and oxytocin. The peptide hormones are found in secretory granules, which traverse the axons within the pituitary infundibulum and await secretion in the neurohypophysis. These peptide hormones and their secretory granules are the source of focal T1 shortening associated with this structure.

When there is incomplete caudal migration of the neurohypophysis, there is an ectopic area of neurohypophyseal T1 shortening, typically along the expected location of the infundibular recess of the third ventricle (Fig 6). This results in a hypoplastic pituitary infundibulum. As the peptide hormones reach the ectopically located neurohypophysis (as evidenced by T1 shortening), there is typically normal neurohypophyseal function; however, the hypothalamic-hypophyseal portal venous system (HHPVS), which carries releasing hormones to the adenohypophysis, does not fully develop. The HHPVS normally traverses the pituitary infundibulum, which in this case is hypoplastic.
Figure 7. Craniopharyngioma in an 8-year-old boy with visual disturbances. (a) Sagittal contrast-enhanced T1-weighted image shows a cystic suprasellar mass (arrow), with a thin peripheral rim of enhancement (arrowhead). The enhancement is slightly thicker along the inferior margin of the cyst wall. (b) Sagittal CT image shows areas of calcification (arrow) along the wall, in particular along the inferior aspect of the cyst wall. A cystic suprasellar mass with areas of calcification is pathognomonic for craniopharyngioma.

An ectopic neurohypophysis is often associated with adenohypophyseal dysfunction, most commonly a growth hormone deficiency. Patients may also have normal to slightly elevated prolactin levels, as prolactin release occurs spontaneously, with an intact HHPVS providing suppressive signaling. Ectopic neurohypophysis is sometimes an associated feature of septo-optic dysplasia (2,10,11).

Craniopharyngioma
Craniopharyngiomas are suprasellar tumors that have a bimodal age distribution, with adolescents more likely to have the adamantinomatous subtype and patients in approximately the 6th decade of life more likely to have the papillary subtype. Many of the masses in adolescents are multicystic, with solid areas of calcification (Fig 7). The cystic areas will have heterogeneous signal intensity characteristics, may have layering fluid levels, and, due to the proteinaceous content, will not suppress at fluid-attenuated inversion-recovery (FLAIR) imaging. The solid areas typically enhance after contrast agent administration. The calcifications seen may be fine, coarse, or both (12,13).

Pars Intermedia Cyst
A pars intermedia cyst (Fig 8) is a cystic structure that manifests within the pituitary gland, between the neurohypophysis and adenohypophysis (14,15). It is predominantly oriented in the coronal plane, along the expected course of the pars intermedia membrane, between the adenohypophysis and neurohypophysis, and therefore
Figure 9. Rathke cleft cyst. (a) Sagittal T1-weighted MR image shows a cyst-like lesion (arrow) in the pituitary gland anterior to the neurohypophysis. The lesion is slightly hyperintense to the anteriorly displaced adenohypophysis. (b) Sagittal contrast-enhanced T1-weighted MR image shows nonenhancement of the cystic contents (arrow). The cyst displaces the adenohypophysis anteriorly (arrowhead) and represents a Rathke cleft cyst.

is thinner in the anterior-posterior dimension than in coronal or transverse dimensions. There should be no mass effect on other structures, and the volume of the adenohypophysis and neurohypophysis should be within normal limits.

Rathke Cleft Cyst
A cystic lesion within the pituitary gland without calcification or a solid enhancing component is likely a Rathke cleft cyst (Fig 9). A Rathke cleft cyst may have a nonenhancing mural nodule that demonstrates T1 shortening, and it may have an internal fluid level likely related to prior microscopic hemorrhage (14–17). Any pituitary area mass with calcification strongly raises suspicion for a craniopharyngioma.

While Rathke cleft cysts are benign findings that are usually discovered incidentally, they can, when large, result in mass effect on the optic chiasm. If there are uncertain features (eg, mural nodularity, possible calcification, or an increase in size), endocrinologic studies can be performed to evaluate for a cystic adenoma. Follow-up imaging is warranted.

Hypothalamic Hamartoma
A hypothalamic hamartoma (Fig 10) is a lesion that may manifest with gelastic seizures (laughing episodes) and central precocious puberty (18). The lesions will be hypointense to gray matter on T1-weighted images and should not enhance after contrast agent administration.

On midsagittal images, hypothalamic hamartomas most commonly manifest as mass-like thickening of the floor of the third ventricle, anterior to the mammillary body. Some hypothalamic
hamartomas are intrinsic to the hypothalamus and are more easily confirmed on axial and coronal images. Postcontrast enhancement is a sign of a neoplasm, such as a pilocytic astrocytoma of the hypothalamus.

**Persistent Craniohypophyseal Canal**
The invagination of a Rathke pouch from the nasopharyngeal mucosa to the sella turcica takes place through the craniohypophyseal canal, a developmental defect in the basisphenoid. While this typically involutes by birth, the craniohypophyseal canal can persist (Fig 11). This is most commonly seen as an incidental finding; however, the pituitary gland may protrude into the canal, possibly with associated endocrine dysfunction, and there may be an associated sphenoid meningocele/encephalocele (19).

A persistent craniohypophyseal canal has been associated with other developmental abnormalities, such as morning glory disk anomaly. Other clival canals or developmental irregularities are differentiated by location. The fossa navicularis magna is a canal, likely related to notochordal development, in the basiocciput (20).

**Cerebellar Entities**

**Chiari I Malformation**
A Chiari I malformation is a cerebellar developmental abnormality that manifests as elongated cerebellar tonsils, which extend caudally below the plane of the foramen magnum (Fig 12) and impair the normal bidirectional pulsatile flow of CSF (21,22). The most common associated clinical symptom is headache; however, tinnitus,
Chiari II Malformation
A Chiari II malformation (Fig 13) has an approximate 1:1 association with an open lumbosacral myelomeningocele (21). The theory is that, because of CSF leakage from the spinal dysraphism, there is lower-than-expected intracranial pressure and resultant sagging of the brainstem and cerebellum. This results in enlargement of the foramen magnum. In a Chiari II malformation, there is caudal cerebellar extension involving the tonsils and the vermis, as compared to the cerebellar tonsillar ectopia in a Chiari I malformation.

Additional features at midsagittal imaging include associated posterior corpus callosal dysgenesis, a large massa intermedia, a beaked appearance of the tectum, and a small posterior cranial fossa, as evidenced by a low position of the torcula and positioning of the internal occipital protuberance lower than that of the external occipital protuberance. A similar intracranial phenotype in the setting of an occipital encephalocele represents a Chiari III malformation (22).
Dandy-Walker Complex: Moderate Severity
Inferior vermian hypoplasia, where the incompletely formed fourth ventricle is in communication with a prominent posterior fossa CSF space, represents a Dandy-Walker spectrum malformation (21) (Fig 16). A variety of terminologies are used for Dandy-Walker spectrum malformations, possibly leading to confusion when consulting different sources. A Dandy-Walker spectrum malformation that is not a “classic” Dandy-Walker malformation is sometimes referred to as a Dandy-Walker variant; however, that terminology does not differentiate mild from severe forms of this malformation.

Dandy-Walker Malformation: Classic Manifestation
A classic Dandy-Walker malformation has a midsagittal appearance of a hypoplastic uplifted vermis that, based on standard imaging orientation, represents counter-clockwise rotation (Fig 17) (21). The fourth ventricle is not clearly identifiable and is in free communication with a cystically dilated posterior cranial fossa. There is elevation of the torcula (and the internal occipital protuberance) relative to the insertion of the nuchal ligament. The torcula may extend to (or above) the level of the lambdoid suture (torcular-lambdoid inversion).

Rhombencephalosynapsis
Rhombencephalosynapsis is a midline fusion abnormality of the cerebellum, with nondevelopment of the cerebellar vermis and midline continuity of the cerebellar hemispheres. Close attention to the foliation pattern at midsagittal imaging shows a nonbranching cerebellar hemispheric pattern, as opposed to the normal branching vermic foliation (Fig 18). The inferior medullary velum is not clearly identifiable, and accordingly there is a narrowed fastigial angle. Rhombencephalosynapsis is commonly associated with aqueductal stenosis (29,30).

Pineal Region Entities
Pineal Cyst
Pineal cysts are physiologic findings, commonly seen in as many as 50% of children when evaluated with thin-section imaging. The characteristic features of a physiologic pineal cyst are a smooth peripheral wall without mural nodularity or a soft-tissue mass (Fig 19). Thin internal septa, and even fluid levels, can occasionally be seen in physiologic pineal cysts. Owing to their proteinaceous contents, physiologic pineal cysts may show incomplete suppression at FLAIR imaging. Features such as mural nodularity, asymmetry, and mass effect on adjacent structures raise the possibility of a pineal neoplasm and will likely require further evaluation. In the absence of mural nodularity or mass effect on adjacent structures, these are typically incidental findings and, if asymptomatic, do not necessarily require follow-up, even when larger than 10 mm (31,32).

Pineoblastoma
Pineoblastomas are high-grade tumors of the pineal gland, most commonly seen during infancy and adolescence (33,34). The lesions have heterogeneous calcifications throughout and may have
Figure 16. Dandy-Walker spectrum malformation of moderate severity in a girl with a history of abnormal prenatal US. (a) Sagittal US image of the head obtained through the anterior fontanelle shows a hypoplastic cerebellar vermis (arrow), with the fourth ventricle (*) in communication with a prominent infravermian CSF space. The medial margin of the cerebellar tonsil (arrowhead) is depicted, which should not be mistaken for a normally developed inferior vermis. (b) Sagittal T1-weighted MR image, obtained in the 10-month-old patient, shows a hypoplastic vermis (arrow) with inferior vermian hypoplasia. The fourth ventricle (*) is in communication with a prominent infravermian CSF space. Note the medial margin of the cerebellar tonsils (arrowhead).

Figure 17. Dandy-Walker malformation in an 8-month-old infant with developmental delay and macrocephaly. Sagittal T1-weighted MR image shows a markedly hypoplastic uplifted cerebellar vermis (arrowhead). As a result, there is free communication between the fourth ventricle and a markedly dilated posterior fossa CSF space (*). There is uplifting of the torcula (arrow). This represents a classic Dandy-Walker malformation.

internal areas of cystic degeneration and/or hemorrhagic necrosis (Fig 20). The solid portions will demonstrate reduced water diffusion. The heterogeneous calcifications and diffusion characteristics help differentiate pineoblastoma from a pineal region germinoma, since germinomas typically cause focal displacement of the intrinsic pineal calcification and are less likely to demonstrate reduced diffusion. However, owing to variability in individual tumors regarding calcification patterns and diffusion characteristics, these features alone are insufficient to fully differentiate pineoblastomas from germinomas. When large, pineoblastomas tend to cause mass effect on the aqueduct of Sylvius and result in obstructive hydrocephalus (35,36).

**Pineal Teratoma**
Pineal teratomas are germ cell tumors that may have heterogeneous areas of calcification and cystic changes and can contain macroscopic fat (Fig 21). Macroscopic fat would be atypical for nearly all other pineal region lesions. While germinomas respond to chemotherapy, teratomas require surgical resection. Accordingly, radiation therapy of a mixed germ cell tumor of the pineal region can result in involution of the germinoma component, which may lead to growth of the remaining teratoma component. This is referred to as growing teratoma syndrome (37).

**Aqueductal Stenosis**
Narrowing of the aqueduct of Sylvius can result in triventricular obstructive hydrocephalus. There is an X-linked congenital form of aqueductal stenosis. Aqueductal stenosis can be an associated feature of rhombencephalosynapsis (30). Acquired aqueductal stenosis can be caused by arachnoid and/or fibrin webs that form after intraventricular hemorrhage or a prior infectious/inflammatory process (Fig 22). Hydrocephalus from aqueductal stenosis is often amenable to treatment with endoscopic third ventriculostomy. In children, where an endoscopic third ventriculostomy may be technically
challenging, shunt placement is often the first-line therapy.

**Tectal Glioma**
A tectal glioma is a low-grade tumor of the tectum (Fig 23). This entity often results in obstruction of the aqueduct of Sylvius and subsequent obstructive hydrocephalus. Symptoms from hydrocephalus are the most common reasons tectal gliomas are identified. Because of the deep location and eloquence of parenchyma in this region, these lesions are not resected and often a biopsy is not performed. Endoscopic third ventriculostomy may be performed to alleviate the hydrocephalus. Follow-up imaging surveillance allows the radiologist to evaluate worsening of the hydrocephalus. If there are changes, radiation therapy of the lesion may be performed.

**Vascular Entities**

**Vein of Galen Aneurysmal Malformation**
A vein of Galen aneurysmal malformation is a congenital abnormality secondary to arteriovenous shunting, related to either an arteriovenous fistula (mural type) or an arteriovenous malformation (choroidal type) of the primitive choroidal vasculature. The characteristically dilated venous structures represent dilatation of the embryologic precursors to the vein of Galen, in particular the median prosencephalic vein of Markowski (38,39). In a choroidal type, an arteriovenous malformation nidus can be identified, as opposed to a mural type where there is a fistula connecting a feeding artery with an enlarged draining vein, without a discrete nidus.

The elevated pressures from the arteriovenous shunting can impair maturation into the vein of Galen (Fig 24). There is often persistence of a
falcine sinus. The pericallosal arteries may be enlarged at midsagittal imaging, representing a persistent limbic arch with the arterial supply to the shunting lesion originating from posterior-superior choroidal artery branches.

Superior Sagittal Sinus Thrombosis
Thrombosis of the superior sagittal sinus may be identified at midsagittal T1-weighted MR imaging by intrinsic T1 shortening (increased signal intensity) related to the presence of intraluminal
Figure 22. Aqueductal stenosis in a 12-year-old boy with ventriculomegaly. Sagittal CISS MR image shows a web (white arrowhead) at the inferior aspect of the aqueduct of Sylvius, with dilatation (**) of the aqueduct, resulting in profound splaying of the third ventricular recesses, anterior displacement of the optic chiasm (black arrowhead), and inferior bowing of the floor of the third ventricle (arrow). These findings are consistent with hydrocephalus related to aqueductal stenosis.

Figure 23. Tectal glioma in an 11-year-old boy with new-onset ventriculomegaly. Sagittal T1-weighted MR image shows enlargement of the tectum (arrow), resulting in effacement of the inferior aspect of the aqueduct of Sylvius (arrowhead). This is hydrocephalus secondary to aqueductal obstruction from a tectal glioma.

Figure 24. Vein of Galen aneurysmal malformation in a 3-month-old infant with high-output cardiac failure. Sagittal T2-weighted MR image shows a dilated venous pouch (**) in the quadrigeminal cistern, representing an aneurysmally dilated vein of Galen. The straight sinus (arrowhead) is atretic, and the outflow is through a dilated persistent falcine sinus (black arrow). The torcula is also dilated (white arrow). When there is specific clinical concern for venous sinus thrombosis, dedicated venography (including CT venography, MR venography, or conventional venography) is warranted, as normal nonenhanced CT or conventional MR imaging results are insufficient to entirely exclude thrombosis.

Additional Entities

Retroclival Epidural Hematoma
The tectorial membrane is contiguous with the retroclival dura. After trauma, the dura can be uplifted from the clivus, resulting in a retroclival epidural hematoma (Fig 26). This injury is more common in children than in adults, and it is often associated with craniovertebral junction ligamentous injury (40). MR imaging can assist in evaluating for tectorial membrane injury and for determining if the collection is subjacent to an uplifted tectorial membrane and therefore epidural or if it is redistribution of a subdural collection between the retroclival dura and the ventral brainstem. When identified, the patients are treated conservatively, possibly treated with immobilization and a flexion-extension distraction evaluation under fluoroscopy after approximately 2 weeks.

Entities Not Included
This review is intended to teach midsagittal anatomy and improve understanding and recognition of 25 specific conditions, with knowledge that there are other entities for which midsagittal imaging is helpful in diagnosis. Beyond the entities
discussed in this article, midsagittal images can assist with the diagnosis of encephaloceles (frontonasal, ethmoidal, basisphenoidal, and occipital); atretic cephaloceles; a variety of types of callosal dysgenesis (including segmental dysgenesis in syntelencephaly); pituitary adenoma; pituicytoma; chiasmatic glioma; tectal lipoma; encystment of the velum interpositum; clival chordoma; clival chondrosarcoma; colloid cyst of the third ventricle; basilar apex aneurysm; septo-optic dysplasia; multiple sclerosis; Susac syndrome; Marchiafava-Bignami syndrome; esthesioneuroblastoma; echordosis physaliphora; and more. It is not for lack of interest or awareness that these topics are not included, but rather they are not included for the goal of maintaining focus.

Conclusion
Midsagittal images provide a wealth of information about a variety of congenital and acquired abnormalities. Understanding the appearance of normal anatomic features, as well as characteristic pathologic features, can allow extraction of maximal information from this important imaging plane.

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