Dandy-Walker Syndrome: A Review of New Diagnosis and Management in Children

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Abstract

Context: Dandy-Walker syndrome (DWS) or malformation (DWM) characterizes a hereditary abnormality categorized via agenesis or hypoplasia of the cerebellar vermis, cystic dilation of the fourth ventricle, and expansion of the posterior fossa with or without hydrocephalus. This review aimed at describing the basic clinic pathologic features of DWS, its diagnosis by other central nervous system (CNS), systemic genetic relatives, and new treatment modalities.

Evidence Acquisition: Training and publishing in this field is very limited. Among 54 articles in this era, a total of in 31 articles were included in the current evaluation.

Results: The etiology of DWS is uncertain, however, is supposed to be a consequence of the mixture of ecological and genetic causes. The most common postnatal appearance is macro crania. Additional signs and symptoms could include huge posterior fossa, sunset sign, seizures, spasticity, apnea, respiratory failure, delayed milestones, hydrocephalus, and increased intracranial pressure. Currently, DWS is diagnosed completely with anatomic definitions that can be recognized on ultrasound or Magnetic resonance imaging (MRI) and computed tomography (CT) intrauterine or postnatal.

Conclusions: Dandy walker syndrome occurs as a comparatively rare origin of hydrocephalus and might go along with numerous inherited CNS and systemic anomalies. Even though it is usually treated for related hydrocephalus, the abnormality causes no detectable clinical syndrome. It is identified with antenatal or postnatal imaging via ultrasound, CT, or MRI. Hydrocephalus and the cyst in posterior fossa can be treated with surgery, via shunting processes, endoscopy, or both. Prognosis has enhanced meaningfully from the time of its original report; yet, it is typically dependent on the accompanying abnormalities.

Keywords: Dandy-Walker Syndrome, Malformation, Diagnosis, Managements, Children

1. Context

Dandy-Walker syndrome (DWS) or malformation (DWM) characterizes a hereditary abnormality categorized via the cerebellar vermis agenesis or hypoplasia , fourth ventricle cystic dilation, and expansion of the posterior fossa. Hydrocephalus is not an obligatory finding. Sutton in 1887 performed the first post-mortem explanation of such scientific representation (1, 2). The malformation was then described by Dandy and Walker in 1921 and 1942 by means of a hereditary fourth ventricular foraminal atresia (3, 4). However, Benda, in 1954, initially used the word Dandy Walker syndrome to define this disorder and suggested a novel philosophy on its etiology (4, 5). Meanwhile, during this period, no important advancement occurred in expressions of etiology; yet, DWS is a famous abnormality that has remained related by other neurogenic and systemic abnormalities, counting genetic abnormalities, congenital infections, and teratogens (5, 6). Developments in radiologic techniques and improved availability might have directed to the over diagnosis of this syndrome (6). Although in contrast to various physical illnesses in children, such as trauma, spine diseases, behavioral disorder, and hydrocephalous, (7-10), the prevalence of DWS is infrequent, yet there is a lot of doubt about the best treatment option for this condition in pediatric patients. This review objects to pronounce the basic clinic pathologic landscapes of DWS and its differential diagnosis by other CNS diseases and new management consideration that are currently existent.

2. Evidence Acquisition

Primarily, Medline, Scopus, Embase via Google scholar, PubMed and Ovid were searched using the following keywords: Dandy-Walker syndrome, posterior fossa, pediatric, diagnosis, and treatment. The criteria involved studies from journals that described Dandy-Walker syndrome pediatric patients. Although some old primary references in this era had to be used, yet based on the philosophy of the researchers, new published articles after 2000 were included in this review. Significant training and publishing in this field is very limited. Among 54 articles in this era, a total of in 31 articles were included in the current evaluation.

3. Results

3.1. Pathogenesis

Cerebellar growth starts in the 9th week of pregnancy once the cerebellar hemispheres begin to genesis. Afterwards, the vermis is created when the hemispheres join together. About the 10th week of gestation, the rhombic vesicle forms the choroid plexus of the fourth ventricle and the foramina of Magendie. Collection of cerebrospinal fluid (CSF) inside the 4th ventricle induces growth (11, 12). It is situated in a way that this developing abnormality is associated with the non-regression of the posterior medullary velum, which remains in place of a dense membrane of arachnoid and ectoderm. There is an absence of cerebellar vermis. Eventually, a cyst is created at the most inferior end of the 4th ventricle, that can divide the cerebellar hemispheres.

Even though frequently realized, defect in the foramina of Magendie formation is not essential pointed at the produce of DWS (12, 13).

3.2. Etiology

The etiology of DWS is uncertain, however, is supposed to be a consequence of the mixture of ecological and hereditary causes. Environmental factors, containing intrauterine contact with teratogens, alcohol, maternal infection, and diabetes, have been shown to be related to the cause of DWM. Recently, the DWS contributing genes, FOXC1 on humanoid chromosome, 6p25 and linked ZIC1 and ZIC4 on human chromosome 3q24, have been recognized (14-16).

3.3. Diagnosis

Traditionally, the only imaging characteristic consistent with DWS was a raised torcular Herophili, visible on skull X-ray (Bucy's sign) (17, 18). Currently, DWS is diagnosed completely with anatomic definitions that can be recognized on ultrasound or magnetic resonance imaging (MRI) and computed tomography (CT) intrauterine or postnatal (Figure 1) (17, 18).

3.4. Prenatal Diagnosis

Regarding the assessment of fetal abnormalities, studies have notified about restrictions caused by diagnosis with ultrasound being conflicting with diagnosis in postnatal or postmortem pathologies (18). Fetal MRI was a useful assistant in identifying this disorder prenatally, given the possibility for related inherited anomalies and occurrence of developmental and cognitive discrepancies (18, 19).

For instance, some mothers might designate to terminate gravidities founded on diagnosis of DWS; it is vital that a precise intrauterine diagnosis is provided by innovative MRI based on CNS and systemic related anomalies and a cytogenic assessment. Chromosomal abnormalities occur in approximately 50% of patients. The most frequent anomalies are Trisomy 18, 13, and triploidy (19, 20). In familial forms, inheritance patterns might be X-linked or autosomal recessive. If DWS is related by a single gene defect, the risk of recurrence can be great for following gravidities, otherwise, the recurrence risk is up to 5% (20, 21). The impending progression of descriptions of hereditary developmental syndromes could permit DWS to be divided to detailed entities labelled in relations of molecular anomalies (19, 21).

3.5. Differential Diagnosis

Dandy-Walker variant is a term that is a smaller range of DWS-like signs that are not corresponding by means of typical characterization. There is a defect in the inferior part of cerebellar vermis and communication among the fourth ventricle and normal cisterna magna (22, 23). An additional term is Dandy-Walker complex invented to define a variety of posterior fossa abnormalities characterized from mild to moderate and severe (agenesis of vermis, dilation of posterior fossa cyst, and fourth ventricle) (24-26).

A number of cerebellar cystic abnormalities are responsible for the foundation of a differential diagnosis in prenatal or postnatal performances. These contain megacisterna magna, DWV, persistent Blake pouch cyst, posterior fossa arachnoid cyst, congenital vermin hypoplasia, and fourth ventriculocele) (Figure 2) (23, 25, 27).

3.6. Natural history and Clinical Symptom

The occurrence of DWS has been found in 1 of 25,000 to 30,000 neonates by the maximum occurrence in infants under 1 year old (24, 28). However, diagnosis might be
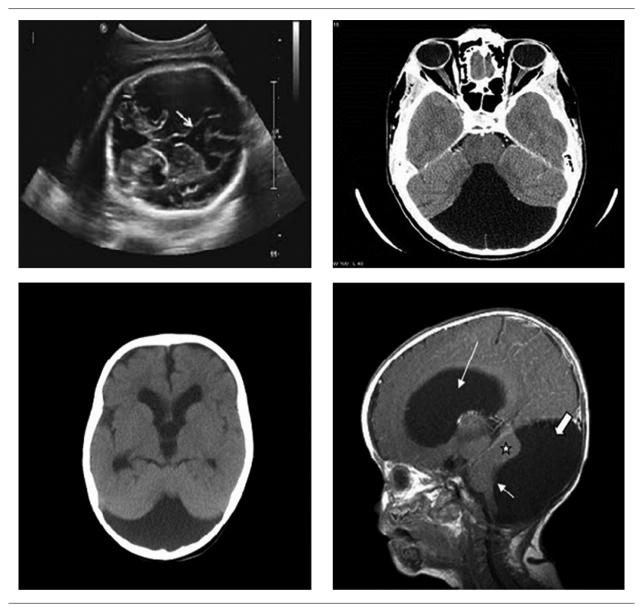
Figure 1. Diagnosis of Dandy-Walker syndrome (DWS). Prenatal ultrasonography demonstrating typical findings associated with DWS in the fetus. CT scan and MRI showed posterior fossa cyst, hydrocephalus (arrows), expanded posterior fossa, and agenesis of cerebellar vermis.

late and occur during adolescence. The age at diagnosis differs depending on the grade of abnormalities. Those, who grow hydrocephalus, are frequently diagnosed by 3 months of age (28, 29). The most common postnatal appearance is macro crania. Additional signs and symptoms could comprise huge posterior fossa, sunset sign, seizures, spasticity, apnea, respiratory failure, delayed milestones, hydrocephalus, and increased intracranial pressure. Elder children might seem alike to patients by cerebellar tumors, and then nystagmus and ataxia have been the most common symptoms (29, 30). The frequency of concomi-

tant abnormalities in the CNS is different up to 68% (28, 29).

Agenesis of corpus callosum is the most common accompanying CNS anomaly (29, 31, 32).

3.7. Extra Cranial Manifestations

In 26% to 38% of DWS cases, the patients also present extra cranial appearances counting congenital heart defects (ventricular septal defects, atrial septa defects, patent ductus arteriosus, pulmonary stenosis, and defect of A V canal), bowel abnormalities, syndactyly, renal disorders like polycystic kidneys, and cryptorchidism. These patients might
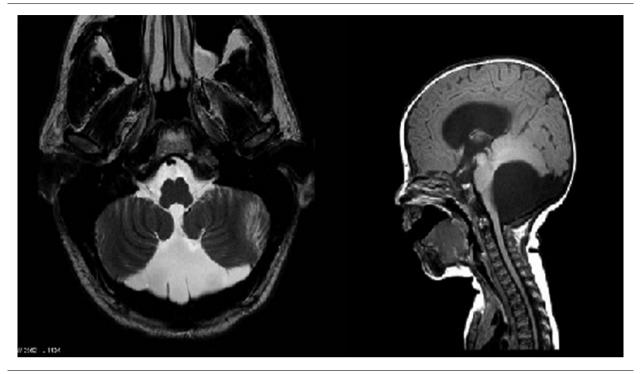
Figure 2. Magnetic resonance imaging showed two important differential diagnoses of Dandy-Walker syndrome. Right axial image: mega-cisterna magna and left sagittal image: arachnoid cyst.

present macrocephaly, cleft palate, cleft lip, hypertelorism, strabismus, high arch palate, and frontal bossing (24, 31). In addition, DWS has been found to be linked with several syndromes, distressing craniofacial elements, containing the oral-facial digital syndrome type I, PHACE syndrome, and Ellis-van Creveld syndrome (31, 32).

3.8. Management

Dandy-Walker Syndrome is treated historically based on the etiologic philosophy of each specific period. In the initial series, based on the acceptance that blockage of the 4th ventricle foramina make hydrocephalus surgical management was included removal of the posterior fossa membranes to enable CSF movement (33, 34). After collection of the information by this technique, its poor efficiency was then confirmed in numerous reports, indicating that 75% of these patients required a shunt insertion (34). Currently, fenestration or resection of blocking membranes might still be a good choice in the management of DWS, predominantly in older children (34, 35).

At present, diversion of CSF through the shunt process is the generally believed ordinary treatment of DWS. However, there is major controversy regarding which shunting technique offers the best consequences (35, 36). Choices contain (1) shunt insertion in the supratentorial part (2) cerebellar cyst shunt insertion (3), shunting cyst and supratentorial sections (dual shunt), or 4) endoscopic methods involving (1) Endoscopic Third Ventriculostomy (ETV), (2) aqueduct stent with shunt insertion, and (3) trans tentorial proximal catheter insertion with shunting by endoscopy (36, 37).

Shunt insertion in the cyst (CPS) alone can be the management of choice. Success of CPS is subject to the primary patency of the aqueduct and consequently documentation of stenosis of aqueduct can define, which process must be done first (34, 36). Ventriculo-Peritoneal shunt (VPS) is easily done and has a comparatively lesser occurrence of malposition or migration. Additionally, VPS is able to offer quick decompression of ventriculomegaly to permit for an acceptable cognitive development (29, 36, 37). However, dysfunction of hypothalamus and aqueduct stenosis due to upward herniation, resulting in an isolated 4th ventricle has been described by shunt insertion in the supratentorial part (29, 35, 36).

Furthermore, there seems to be a tendency between brain surgeons to firstly shunt (CPS or VPS) without removal of membranes of posterior fossa (35, 37). In cases of failure, the primary system might be changed to a dual system. Through the existence of stenosis of aqueduct, a combined technique of ETV and aqueduct stent or a dual shunt

could be the alternative decision (29, 36).

Moreover, there are definite further exclusive conditions that can permit a more adjusted method for treatment of each patient, like existence of an occipital meningocele (37). Regardless of treatment decisions, the main final line is constant, and extent of patient survival without technical complications. Also, with the advance of novel diagnostic and treatment procedures, stress has been lifted to improve functional and cognitive prognosis, creation it problematic to directly match studies by means of unlike surgical approaches to treat DWS (29, 36).

3.9. Outcome

Children with DWS have unpredictable scenarios. This is not only owing to the range of severity of disease but also to the related situations. The death rate has obviously enhanced at the initial years once the disorder was documented (33, 35). This development is in line with improvements in management care and a more sufficient control of hydrocephalus. Currently, mortality frequently occurs secondary to shunt malfunction or infection and accompanying systemic abnormalities (29, 36).

In children, who have effectively been operated for hydrocephalus, the outcome is dependent on accompanying disorders. Outcome might be worse with visual defects, hearing loss, seizures, and other neurogenic and systemic anomalies (35). In the lack of other anomalies, some writers report a normal intelligent quotients (IQ) in 30% and up to 80% of long standing survivors (29, 38).

Vermian lobulation can be a valuable predictive factor particularly once applied to prenatal MRI (38, 39).

4. Conclusions

Dandy walker syndrome occurs as a comparatively rare origin of hydrocephalus and might go along numerous inherited CNS and systemic anomalies. Even though, usually treated for related hydrocephalus, the abnormality causes no detectable clinical syndrome. It is identified with antenatal or postnatal imaging via ultrasound, CT, or MRI. Hydrocephalus and the cyst in posterior fossa can be treated with surgery, via shunting processes, endoscopy, or both. Prognosis has enhanced meaningfully from the time of its original report; yet, it is typically dependent on the accompanying abnormalities.

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