CASE REPORTS

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Anatomic variants in Dandy–Walker complex

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Abstract

Dandy–Walker complex (DWC) is a malformative association of the central nervous system. DWC includes four different types: Dandy–Walker malformation (vermis agenesis or hypoplasia, cystic dilatation of the fourth ventricle and a large posterior fossa); Dandy–Walker variant (vermis hypoplasia, cystic dilatation of the fourth ventricle, normal posterior fossa); mega cysterna magna (large posterior fossa, normal vermis and fourth ventricle) and posterior fossa arachnoid cyst. We present and discuss four cases with different morphological and clinical forms of the Dandy–Walker complex. In all four cases, diagnosis was reached by incorporation of clinical (macrocephaly, seizures) and imaging [X-ray, computed tomography (CT), magnetic resonance imaging (MRI)] data. Two patients were diagnosed with Dandy–Walker complex, one patient was diagnosed with Dandy–Walker variant in a rare association with neurofibromatosis and one patient was diagnosed with a posterior fossa arachnoid cyst associated with left-sided Claude Bernard–Horner syndrome, congenital heart disease (coarctation of the aorta, mitral stenosis) and gastroesophageal reflux. In all forms of DWC, the clinical, radiological and functional manifestations are variable and require adequate diagnostic and therapeutic measures.

Keywords: Dandy–Walker, macrocephaly, MRI.

Introduction

Dandy–Walker malformations are defined by: agenesis or hypoplastic cerebellar vermis and cystic dilatation of the fourth ventricle (V4). Communication of V4 with a retrocerebellar cyst can produce the enlargement of the posterior fossa and the upward displacement of the tentorium, appreciably imagistically by the high position of the torcula and of the sinuses. 70–90% of the patients associate communicant hydrocephaly with the enlargement of the lateral ventricles.

Cystic malformations of the posterior fossa include: Dandy–Walker malformation, Dandy–Walker variant, mega cisterna magna, arachnoid cyst of the posterior fossa [1, 2].

Precisely differentiating of these malformations may not be possible using imagistic methods. It is thought that these malformations represent a continuum of development anomalies in a spectrum, called Dandy–Walker complex [3, 4].

Physiopathology

Dandy–Walker malformations are formed during embryogenesis, at 7–10 weeks of gestation, by the perturbation, at different degrees of severity, both of the development of the cerebellar hemispheres and of the fourth ventricle. The nature and the cause of the insult are unknown [5, 6].

Inheritance

The etiology of DWC is heterogeneous. The recurrence risk in a family is 1–5%. Often, the anomaly is associated with other congenital malformations as: congenital heart malformations, cleft palate, neural tube defects, urinary malformations. The more likely locus of the gene is on the long arm of chromosome 3 (3q24-3q25.1) [7, 8]. As predisposing factors are implies the exposure at teratogens during the first trimester of pregnancy (rubella, cytomegalovirus, toxoplasmosis, warfarin, alcohol).

Frequency

In the USA, the incidence of the Dandy–Walker malformation is one case per 25 000–35 000 live births, but there is also given higher frequencies until 1:5000 live births [9]. The malformation accounts for approximately 1–4% of the hydrocephaly cases. Gender ratio (males/females) is 1:3, in one Spanish series. The mortality rate in the pediatric neurosurgical services is 12–50%. Associated congenital anomalies contribute to 83% of postnatal deaths [10, 11].

Case presentations

We present and discuss four cases with different morphological and clinical forms of the Dandy–Walker complex. In all four cases, diagnosis was reached by incorporation of clinical (macrocephaly, seizures) and imaging [X-ray, computed tomography (CT), magnetic resonance imaging (MRI)] data.

Case No. 1: Dandy–Walker malformation

A 2-year-old boy (Figure 1) was presented in our Service for seizures. He was the fourth child in the family.

The pregnancy was normal. He was born at 40 weeks gestational age. The newborn was 4250 g weight and 49 cm height. A mild hypoxia was related at birth. The parents are young and healthy, no consanguineous. He had a sister diagnosed with Fraser syndrome who died at the age of 11 years. The first symptoms appeared at one year of age as generalized seizures and neuro-psychic retardation. Clinical examination revealed cranio-facial dysmorphism: macrocephaly (head circumference at 95th percentile); hypertelorism, large nose, down-slanting palpebral fissures; low-set ears; strabismus; severe psychomotor retardation; ataxia; spasticity. Cranial X-ray shows occipital digital impressions. Brain CT shows: hypodense formation with densities closes to those of cerebrospinal fluid (CSF), which occupies approximately half of the posterior fossa and communicates with the posterior horn of the lateral right ventricle, which is dilated, the absence of the vermis and dilatation of the fourth ventricle (Figure 2). He was only treated with anticonvulsant drugs. He had no recommendation for surgical treatment. Clinical evolution was unfavorable, with uncontrolled convulsions, severe psychomotor retardation and death at the age of 11 years.

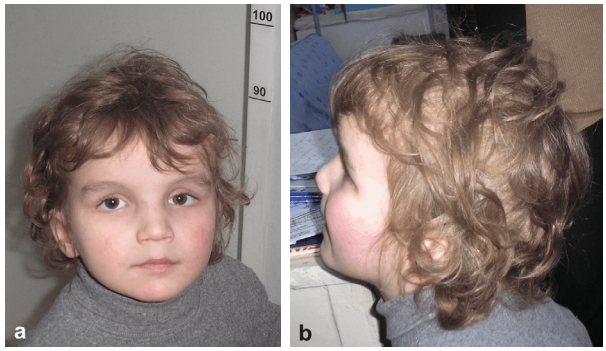

Figure 1 – ***(a) Macrocephaly, hypertelorismus, strabismus large nose, down-slanting palpebral fissure; (b) High forehead, low-set ears.***

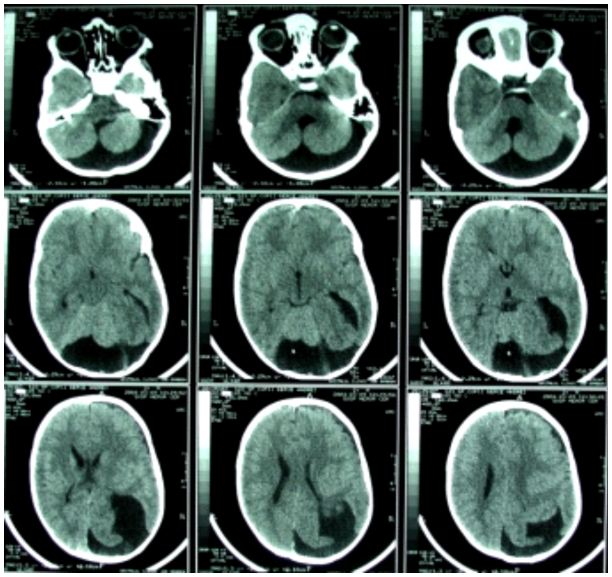

Figure 2 – ***Dandy–Walker malformation. CT scan: hypodense formation with densities closes to those of CSF, which occupies approximately 1/2 of the posterior fossa and communicate with the posterior horn of the lateral right ventricle being much dilated; absence of the vermis; dilatation of the fourth ventricle.***

Case No. 2: Dandy–Walker malformation

A 11-month-old girl (Figure 3) was referred to our Department for macrocephaly (cranial circumference above 95th percentile). The girl is the second child in the family. The pregnancy was normal. The parents are young, healthy and unrelated. She was born at full term by normal vaginal delivery. The birth weight was 3200 g and the height 51 cm. She has no pathological familial history. Physical examination revealed a large cranium. No other congenital abnormalities associated; no mental retardation, no neuromotor delay. Cranial X-ray shows: coronal suture with contoured edges flu; open anterior fontanel, almost completely closed posterior fontanel. Brain CT revealed Dandy–Walker malformation (vermis agenesis, mega cisterna magna, hydrocephaly) (Figure 4). Surgical treatment (endoscopic ventriculocisternostomy at 20 months of age) was followed by a good evolution.

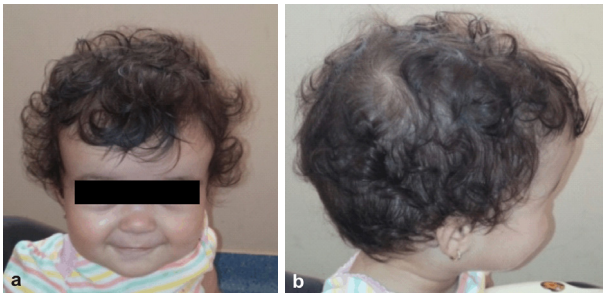

Figure 3 – ***(a) Macrocephaly; (b) High forehead, bulging occiput.***

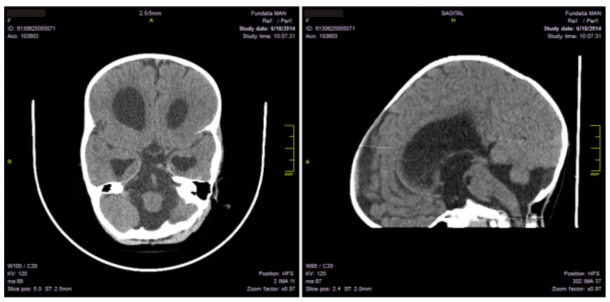

Figure 4 – ***Dandy–Walker malformation. CT scan: hydrocephaly, vermis agenesis, mega cisterna magna.***

Case No. 3: Dandy–Walker variant

A 5-year-old boy (Figure 5) was presented in our Department for macrocephaly (cranial circumference above 95th percentile). He was the first child in the family. The parents are young, unrelated. The mother and maternal grandmother have both neurofibromatosis type 1. He was born after a normal pregnancy and delivery. The birth weight was 4000 g and the height 57 cm. At the age of three years, he presented paresis of external oculomotor nerve. Physical examination showed: macrocephaly, anti-mongoloid palpebral fissures, bilateral epicanthus, decollated and low-set ears, moderate growth retardation, no mental retardation. He associated signs of neurofibromatosis type 1 (>6 spots „café-au-lait" with diameter greater that 5 mm). Cranial X-ray shows: bilateral incipient cervical rib and the occipitalization of the first vertebra. Brain MRI exam relieved: hypoplasia of inferior vermis; asymmetry of cerebellar hemispheres (hypoplasia of the left cerebellar hemisphere); the elevation of the cerebellar

tentorium; moderate dilatation of the fourth ventricle (Figure 6). At 15 years of age, he has a good clinical evolution. No indication for surgical or medical treatment just now.

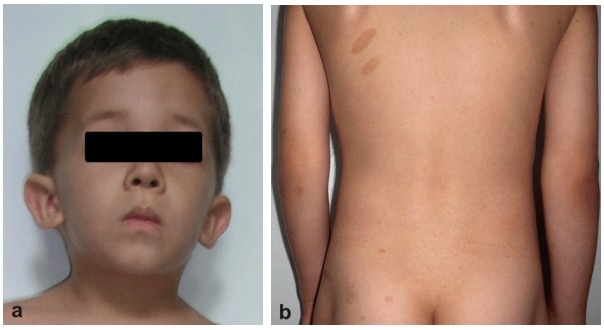

Figure 5 – *(a) Macrocephaly, anti-mongoloid palpebral fissures; decollated, low-set ears; (b) "Café-au-lait" spots with diameter greater that 5 mm.*

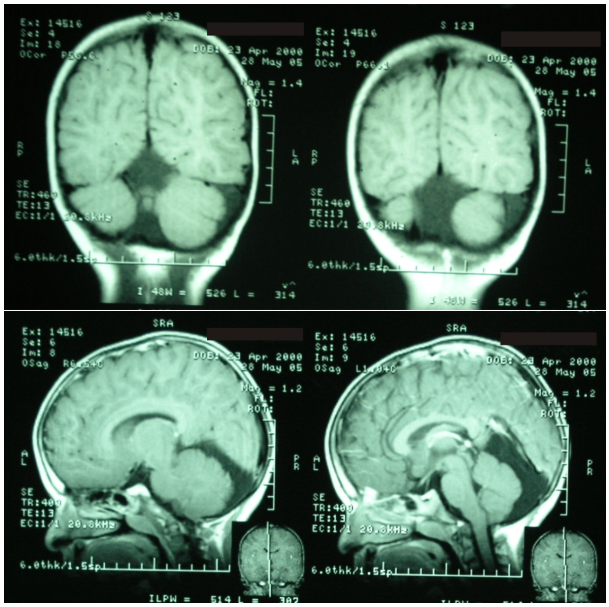

Figure 6 – *Dandy–Walker variant. Brain MRI: inferior vermian hypoplasia; asymmetry of cerebellar hemispheres, with hypoplasia of the left cerebellar hemisphere comparative to the right one; elevation of the cerebellar tentorium, with moderate dilation of the fourth ventricle.*

Case No. 4: Arachnoid cyst of posterior fossa

A boy at nine months of age (Figure 7) was referred in our Department for macrocephaly (cranial circumference at 90th percentile). He is the first child of healthy, non-consanguineous parents. No preceding family history of neurological or neuromuscular diseases. He was born at term *via* caesarean section with 3400 g and 54 cm. Symptoms began at six months of age with apnea crises. Clinical examination relieved: macrocephaly, down-slanting palpebral fissures, bilateral simian crease, left Claude Bernard–Horner syndrome, moderate psycho-motor retardation. He had associated complex congenital heart malformation (coarctation of the aorta, bicuspid aortic valve, mitral stenosis, foramen ovalae) operated at 10 months of age. Brain MRI shows: cerebellar interhemispheric arachnoid cyst of approximately 3/3 cm, asymmetry of cerebellar hemispheres, vermian agenesis, cortico-subcortical atrophy, moderate secondary intern hydrocephaly (Figure 8). At 14 years of age, he has a good evolution; no surgical indication just now.

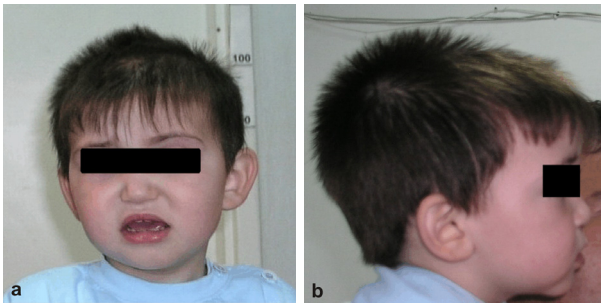

Figure 7 – *(a) Macrocephaly, down-slanting palpebral fissures, large mouth; (b) Low-set ears, bulging occiput.*

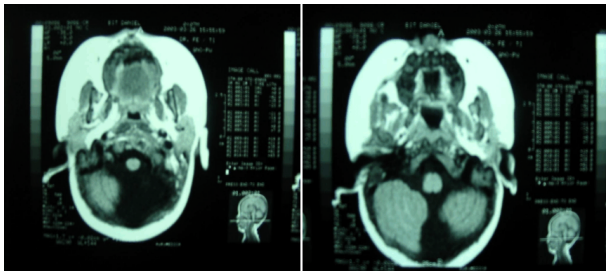

Figure 8 – *Arachnoid cyst of posterior fossa. Brain MRI: cerebellar interhemispheric arachnoid cyst of approximately 3/3 cm, with asymmetry of cerebellar hemispheres; vermian agenesis, cortico-subcortical atrophy; moderate secondary intern hydrocephaly.*

Discussion

The Dandy–Walker malformations recognize three anatomic characteristic features: dysgenesis of the vermis, cystic dilatation of the fourth ventricle, enlarged posterior fossa with upward displacement of lateral sinuses, of the tentorium and of torcula. The cerebellum is poorly developed, displaced upwards and laterally. The fourth ventricle is grossly misshapen and is a membrane-wrapped cyst that extends into the foramen magnum. The cyst may lift and displace the posterior portion of the brain, as well as may cause an internal obstruction of normal CSF flow with consecutive hydrocephaly. Dandy–Walker malformation may be associated with other central nervous system (CNS) malformations as corpus callosum agenesis, atresia of the foramen of Magendie and, possibly, of the foramen of Luschka [12, 13].

Affected individuals have enlarged head circumference, signs and symptoms of hydrocephaly. Is estimated that 80% of the patients have normal ventricles at birth, but by one year of age, 80% develops ventriculomegaly. Hydrocephaly is present in approximately 90% of patients [14, 15]. Macrocephaly is, usually, the consequence of the hydrocephaly, but can results from massive enlargement of the posterior fossa by the posterior fossa cyst. In this situation, the macrocephaly precedes development of the hydrocephaly, giving the skull a dolichocephalic shape characteristic, with bulging of the occiput. Also, could appear neurological signs as balance difficulties, spasticity, ataxia, poor control of the fine movements. The interference with respiratory control centers in the brainstem may cause respiratory failure. Other disorders

which can occur: development delay, seizures (15–30% of the patients), hearing and/or visual difficulties, systemic abnormalities [16–18]. Sawaya & McLaurin showed that subnormal intelligence [IQ (intelligence quotient) <83] appear at 41–71% of the patients. The most severe intellectual impairment has been observed in patients with agenesis of the callous body [19]. There was no significant relationship between mental retardation and associated anomalies, although agenesis of the corpus callosum was related to poor intellectual development [20, 21]

Conventional radiography is useful especially for the evaluation of the abnormal cranial bones. Also, it is useful in the diagnosis of the Dandy–Walker malformation and in the appreciation of the efficiency of the ventricular shunt at the patients with shunt. Elective investigations for the diagnosis of these malformations are cranial CT and brain MRI (preferably). Brain MRI is the optimal exploration for the differentiation of the Dandy–Walker malformation from other posterior fossa pathologies. Usually, the MRI investigation is required for better anatomic resolution prior to surgical intervention [22]. Ultrasonography is the initial examination performed since it can be done portably, without sedation and allows multiplanar imaging but does not image well such abnormalities as the gyral, dural, tentorial and skull anomalies accompanying the Dandy–Walker malformation.

The association of Dandy–Walker malformation with the congenital heart malformations is revealed in literature. Contrary, the association to neurofibromatosis is described very rare [23, 24]. Koul *et al.* (2000) reported the presence of Dandy–Walker syndrome in association with neurofibromatosis in monozygotic twin [25]. At our patient with Dandy–Walker variant (often asymptomatic even at the adult age), it would not be excluded that one of the ancestors, known with neurofibromatosis, can be associate with Dandy–Walker variant.

The most cases of Dandy–Walker malformation are sporadic, with no history of the disorder in their family. However, a small percentage of cases seem to run in families. Dandy–Walker malformation does not have a clear pattern of inheritance. Multiple genetic and environmental factors likely play a part in determining the risk of developing this disorder. Christian *et al.* (1980) reported the unusual case of an infant with both Ellis–van Creveld syndrome and Dandy–Walker syndrome with homozygosity for an unusually long heterochromatic segment of the long arm of chromosome 9 (9qh+) [26].

Optimal treatment consists of correction of hydrocephalus by cystoperitoneal shunt, ventriculoperitoneal shunt or both shunts [27–29]. Mallikarjun *et al.* reported that routine dental care is advised, if the child is receiving treatment for seizure control. Antibiotic prophylaxis is recommended for all dental treatment to prevent bacterial endocarditis, especially the child treated with ventriculoatrial shunt [30].

The prognosis is difficult to formulate. Only moderately favorable even if the hydrocephalus is precocious and correctly corrected. Severity level is very large. Associations to other congenital anomalies aggravate the prognostic. Dandy–Walker variant can be asymptomatic the whole life.

Medico-legal traps

Failure to diagnose Dandy–Walker malformation with hydrocephaly in a neonate or a child can cause serious neurological complications. Faulty diagnosis as mega cisterna magna or arachnoid cyst instead of Dandy–Walker malformation can be cause of morbidity or mortality [31].

Conclusions

The Dandy–Walker complex is a rare pathological entity still insufficiently known under etiologic and physiopathological aspects. The Dandy–Walker complex has a very wide variability of phenotypic expression, making hard and, sometimes, possible eluded. The macrocephaly, as a constantly present sign, associated with any other neurological sign forces the detailed exploration of CNS. Any detected congenital anomaly needs the detailed global investigation of the patient for the detection of other anomalies, the associations being frequent and, often, unexpected. Any family with special genetic history needs greater attention and, if need be, directed investigations. The election investigation for the Dandy–Walker complex is brain MRI. The prognostic is difficult to anticipate and is influenced by the coexistence of other congenital anomalies.

Conflict of interests

The authors declare that they have no conflict of interests.

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