A 15-year-old school girl presented with nausea and vomiting for two weeks. She had spasticity of the left lower extremity with normal sensation and paraparesis and cognitive impairment. Her mother had a history of cerebral arteriovenous malformation that was associated with hydrocephalus. Magnetic resonance imaging was further examined and revealed dilation of both lateral ventricular and periventricular hyperintensity on the periventricular area. Diagnostic angiography was performed which showed the presence of a dural fistula between occipital sinus and multi-side of Galen vein. Embolization with onyx was performed successfully.

**CASE PRESENTATION**

A 15-year-old school girl presented with nausea and vomiting for two weeks. She had a history of cardiac arrest which required cardiopulmonary resuscitation at 20 days old secondary to fulminant pneumonia. She also developed cognitive impairment since then. In family history, her mother had a history of hydrocephalus and cerebral arteriovenous malformation. On initial computed tomography scan, it showed the presence of obstructive hydrocephalus and the presence of dural arteriovenous fistula (DAVF) (Fig. 1A). Magnetic resonance imaging was further examined and revealed dilation of both lateral ventricular and hyperintensity on the periventricular area (Fig. 1B).

Diagnostic angiography was performed which showed the presence of a dural fistula between occipital sinus and multi-side of Galen vein (Fig. 2). Embolization with onyx was performed successfully. The patient recovered with favorable improvement and was discharged seven days following endovascular therapy.

**DISCUSSION**

Obstruction of the cerebrospinal fluid pathway in the ventricles system by an enlargement drainage vein or brain arteriovenous malformations had been also implicated as the cause of hydrocephalus. However, distant venous outflow obstruction that produces...
hydrocephalus was due to a combination of poor venous drainage and mass effect from dilated sinuses.\(^3\)

Nakahara \textit{et al.} reported a case of normal pressure hydrocephalus which was associated with cortical venous reflux from transverse-sigmoid to superior sagittal sinus. It also may have impaired venous drainage due to venous hypertension from the fistula. In that case, hydrocephalus was caused by a difference in pressure between the venous sinuses and subarachnoid space.\(^2,3\)

Cerebrospinal fluid is absorbed from the subarachnoid compartment through arachnoid villi or granulations that project into the venous sinuses of the dura mater on the cerebral convexity.\(^2,6\) Hydrocephalus secondary due to venous hypertension may be observed in younger patients with high flow fistulae and vein of Galen malformations without ventricular obstruction.

In DAVF, intraventricular hemorrhage may also cause obstructive hydrocephalus. Kataoka \textit{et al.} reported a case of obstructive hydrocephalus resulting from small hemorrhage in lateral and third ventricles and shown spontaneous resolution.\(^7\) Satoh \textit{et al.} reported four cases of cerebellar hemorrhage near the fourth ventricle and all of them developed hydrocephalus.\(^8\) In our case, hydrocephalus might have been caused by progressive parenchymal venous engorgement due to high-pressure venous reflux. This is a novel mechanism that neurosurgeons should be well aware of.

The clinical manifestation of DAVF is usually related to the flow through the fistula which causes pulsatile tinnitus or cavernous sinus symptoms in the case of carotid-cavernous fistula. Besides frank hemorrhage, the varieties of non-hemorrhagic neurologic deficits reported were myriad due to the heterogeneous nature of the lesions.\(^2,3\)

Although hydrocephalus is rarely reported with DAVF, an alternative mechanism of hydrocephalus is related to generalized cerebral venous hypertension that inhibits the absorption of cerebrospinal fluid via arachnoid granulations. In our case, we suggested that the development of hydrocephalus was due to a combination of poor venous drainage and mass effect from dilated sinuses.\(^3\)

Although hydrocephalus is rarely described yet for the adult population,\(^2,4\) hydrocephalus is rarely associated with DAVF. There was a study reporting hydrocephalus associated with spinal perimedullary AVM.\(^5\) In arteriovenous malformation, hydrocephalus can be occurred due to rupture of DAVF and leads to intraventricular or subarachnoid hemorrhage. This hemorrhage can lead to subsequent blockage of the arachnoid villi or intracranial cisterns surrounding the brainstem and cause obstructive hydrocephalus. Overproduction of cerebrospinal fluid due to choroidal brain arteriovenous malformations could also be the cause of hydrocephalus.\(^5\)

Venous congestion had not been described yet for the adult population.\(^2,4\) Venous congestion had not been described yet for the adult population.\(^2,4\) Although hydrocephalus is rarely reported with DAVF, an alternative mechanism of hydrocephalus is related to generalized cerebral venous hypertension that inhibits the absorption of cerebrospinal fluid via arachnoid granulations. In our case, we suggested that the development of hydrocephalus was due to a combination of poor venous drainage and mass effect from dilated sinuses.\(^3\)

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In infants with open fontanelle, hydrocephalus leads to an increase in head circumference due to its ability to expand the intracranial compartment. However, in older children and adults, hydrocephalus leads to raised intracranial pressure due to rigid and fixed intracranial compartments. Earlier, DAVF required surgical disconnection of the fistula to the affected sinus. However, with the advancement of modern endovascular therapy techniques, high-risk fistula can be managed with embolization of Onyx (Ethylene-vinyl alcohol; Covidien neurovascular, Dublin, Ireland), either transarterial, venous outflow occlusion or combination with surgical treatment. In our current case, the hydrocephalus was caused by venous congestion of the vein of Galen due to the presence of DAVF.

Wilson et al. reported a case of communicating hydrocephalus which was caused by an unruptured arteriovenous fistula located in the perimedullary region at L1 level. They postulated that either central venous hypertension or reduced cerebrospinal fluid resorption was the cause of hydrocephalus. Central venous hypertension was thought to be caused by a high-flow fistula. Reduced cerebrospinal fluid resorption through arachnoid granulation in the lumbar region of the spinal cord was thought to be caused by the change in cerebrospinal fluid hydrodynamic.

Regarding the management, initial treatment should focus on the management of the fistula. Hydrocephalus should be managed only when necessary.1,3,11,12

CONCLUSION

The prevalence of the DAVF of the occipital sinus accompany by hydrocephalus due to vein of Galen congestion is not clear. Venous dilatation due to DAVF is the cause of hydrocephalus due to obstruction of cerebrospinal circulation. More studies are needed to investigate this pathology to determine its prevalence and pathophysiological mechanism.

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