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Case Report

Dilation of the olfactory bulb cavity concurrent with hydrocephalus in four small breed dogs

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Four small breed dogs were admitted with seizures. Magnetic resonance imaging (MRI) of the brain revealed dilation of the olfactory bulb cavity as well as enlargement of the lateral ventricles. These findings demonstrate that dilation of the olfactory bulb cavity can occur concurrent with hydrocephalus. This is the first description of the clinical and MRI features of dilation of the olfactory bulb cavity concurrent with hydrocephalus in dogs.

Keywords: dog, hydrocephalus, olfactory bulb cavity, seizure

Hydrocephalus is characterized by increased cerebrospinal fluid (CSF) volume and associated with dilation of the ventricular system of the brain resulting from abnormal CSF drainage due to a congenital anomaly, secondary to mass lesions, or inflammation [6,9]. There is increasing evidence that CSF drainage takes place not only at the arachnoid villi, but also several extracranial sites [9]. The evidences for communication between the CSF pathways and the extracranial lymphatic system by the nasal lymphatics in various animals, including mice, rats, rabbits, sheep, pigs, monkeys, and humans [1,4,5,7,11] have been reported. Therefore, the nasal lymphatics might serve as a reserve mechanism for, or be primarily involved in the absorption of CSF in hydrocephalus.

A 3-year-old intact female Miniature Poodle (Case 1), a 3-year-old intact female Chihuahua (Case 2), an 8-year-old intact male Yorkshire terrier (Case 3), and a 16-year-old intact male Yorkshire terrier (Case 4) were referred to Konkuk University Teaching Animal Hospital with seizures. The neurological examination in Case 2 revealed a left-sided head tilt, strabismus, and decreased postural reactions. Case 4 had an elevated blood urea nitrogen and elevated creatine kinase on the serum biochemistry profile. In the other two cases, the neurological examination and the magnetic resonance imaging (MRI) results were not remarkable. The MRI of the brain using a 0.2 Tesla magnet (E-Scan; Esaote, Italy) revealed dilation of the lateral ventricles and the olfactory bulb cavity. MRI of patients were presented in Fig. 1. For Case 1, food was presented beneath the nose of the dog to examine olfaction and normal sniffing behavior was observed. In addition, the dog was challenged with a piece of cotton soaked with 10% acetic acid to each nostril. Olfaction was reduced unilaterally on the affected side. The neurological signs of these patients were improved by medication including prednisolone (Chorus Pharma, Korea) and furosemide (Handok Pharma, Korea). In Case 3, the seizures recurred and were controlled by phenobarbital (Daihan Pharm, Korea).

Dilation of the olfactory bulb cavity in these cases was found with hydrocephalus. All of these patients were small breed dogs which were predisposed to hydrocephalus [3]. Both of communicating and non-communicating types were included. Therefore, the dilation of the olfactory bulb cavity can be considered regardless of types of hydrocephalus. Even though the seizure activity was not directly related to the olfactory bulb cavity, it could be associated with increased intracranial pressure.

CSF is produced primarily in the choroid plexuses of the cerebral ventricles, flows through the subarachnoid space, and eventually returns to the venous system [5]. The olfactory nerve is ensheathed by meningeal coverings that enclose a subarachnoid space. This perineurial persistence of the subarachnoid space allows CSF flow along the olfactory nerves [2,6]. The pathway of olfactory perineurial CSF drainage is outlined below. The olfactory tract leaves the brainstem and expands into the olfactory bulbs. The olfactory nerve fibers pass the cribriform foramina in the cribriform plate of the ethmoid bone. After penetrating the cribriform foramina, the olfactory nerve fibers enter the

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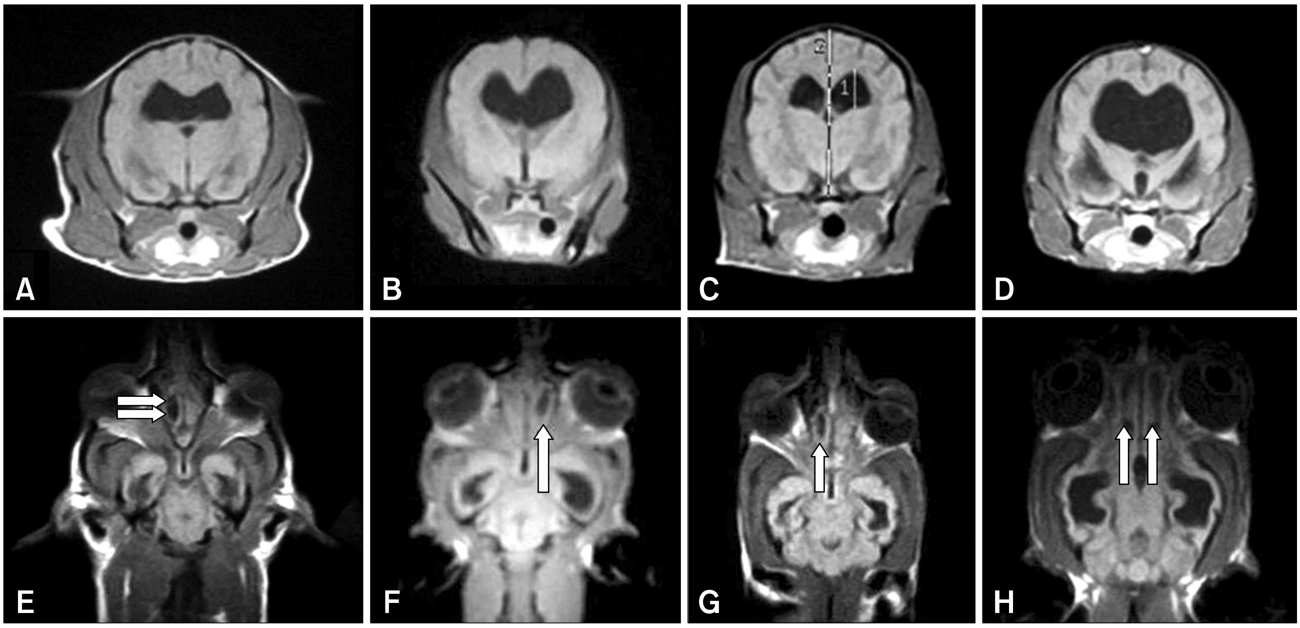

Fig. 1. MR images obtained from patients. (A-D) Transverse T1-weighted images (WI) of Case 1, 2, 3, and 4 show the enlarged lateral ventricles, respectively. (E-H) Dorsal T1-WI of Case 1, 2, 3, and 4 show hypointensity lesion (arrows) in olfactory bulb, respectively.

nasal mucosa in the roof of the nasal cavity, where they terminate. At this point the lymph within the ethmoidal lymphatics appears to be continuous with CSF in the perineurial spaces associated with the olfactory nerves [5,10]. Therefore, damage to the olfactory perineurial sheath to nasal lymphatic outflow tracts might increase intracranial pressure (ICP). There has been a study in rats showed that nasal lymphatic CSF absorption was reduced in the hydrocephalus model [8], though unclear if it was involved in hydrocephalus.

Additionally, the increased ICP leads to compressive neurologic symptoms. In humans, the increased CSF pressure expands the subarachnoid space in perineurial sheath, leading to compression of the optic nerve, and ultimately visual dysfunction [3]. Therefore, the elevated ICP could compromise the function of olfactory nerve. In animal patients, examination of olfaction is difficult. We examined olfaction of one dog (Case 1), indirectly by presenting a morsel of food beneath the nose and observing for normal sniffing behavior [2]. Additionally, each nostril challenged with 10% acetic acid, but the adequacy of its concentration might be questionable. In both trials, the responses were decreased unilaterally on the affected side.

Hydrocephalus occurs with several brain malformations such as the Dandy-Walker syndrome, Chiari malformations, and syringomyelia/hydromyelia, which leads to disruption of the normal CSF flow mechanisms [2]. However, the association of the olfactory system with hydrocephalus has not been reported previously. Furthermore, since only four dogs were presented in this case reports, larger studies along these lines are warranted.

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