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NOTE

Surgery

# Intracranial ectopic choroid plexus cyst in a dog

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**ABSTRACT.** A 4-year-old male Toy Poodle was presented with a history of status epilepticus. On presentation, neurological examination revealed a delay in postural reactions in the right pelvic limb. Magnetic resonance imaging showed a fluid-containing cystic lesion that compressed the mesencephalon, hippocampus, and amygdala. The cyst was surgically removed via left rostrotentorial craniotomy. The final diagnosis was an intracranial ectopic choroid plexus cyst. The patient has remained free of seizures for 18 months after surgery. This is the first case report of an intracranial ectopic choroid plexus cyst that was surgically removed in a dog.

**KEY WORDS:** choroid plexus cyst, dog, ectopic

Non-neoplastic intracranial cysts can cause clinical signs due to compression of the brain [18]. Intracranial cysts include arachnoid diverticula, epidermoid cysts, dermoid cysts, ependymal cysts, porencephalic cysts, and choroid plexus cysts. Intracranial choroid plexus cysts are rare in humans and dogs [15, 18]. They are found in the lateral and third ventricles in humans. There are few case reports of intracranial ectopic choroid plexus cysts in humans [4, 20, 21]. Intracranial choroid plexus cysts have been reported in two dogs, with cysts in both cases being located in the fourth ventricle [1, 7]. We present herein the first case of an intracranial ectopic choroid plexus cyst that compressed the mesencephalon, hippocampus, and amygdala.

A 4-year-old male Toy Poodle was admitted with a history of status epilepticus. The dog had been healthy until he developed seizures. The dog had a current vaccination history and no known history of toxin exposure or trauma. The dog had been given zonisamide (Consave; DS Pharma Animal Health, Osaka, Japan, 3.7 mg/kg PO q12 hr) to treat status epilepticus. The mental status of the dog was lethargic. Neurological examination revealed a delay in postural reactions in the right pelvic limb. Complete blood count and serum biochemistry were within normal reference ranges. Thoracic and abdominal radiographs were unremarkable. Computed tomography (CT) and magnetic resonance imaging (MRI) were suggested in order to identify possible intracranial lesions. Under general anesthesia, CT and MRI were performed. Anesthesia was induced by propofol (PropoFlo; Zoetis Japan, Tokyo, Japan) at a dose of 5.0 mg/kg and maintained by isoflurane (IsoFlo; Zoetis Japan) and $O_2$. Imaging by CT (Asteion Super 4 CT Scanner, Canon Medical Systems, Tochigi, Japan) revealed a 1.3 × 1.0 × 0.9-cm, left-sided, space-occupying, cystic lesion between the mesencephalon and hippocampus. T2-weighted (T2W), T2W-fluid attenuated inversion recovery (FLAIR), and T1-weighted (T1W) images were acquired with a 0.4 T MRI unit (APERTO Lucent Open MRI, Hitachi Healthcare Manufacturing, Kashiwa, Japan). Additional T1W images were acquired following intravenous administration of a gadolinium-based contrast medium (Gadodiamide Hydrate; FujiPharma Corp., Tokyo, Japan) at the dose of 0.2 m*l*/kg. The cystic lesion displayed a strong hyperintense signal similar to that of cerebrospinal fluid (CSF) on T2W images near the mesencephalon (Fig. 1A). Compartments in the cystic lesion were hypointense to isointense on FLAIR sequences (Fig. 1C). On axial images, the cystic lesion compressed the mesencephalon medially, and the hippocampus and amygdala dorsolaterally. A clear communication between the cyst and the lateral ventricle was not observed. The compressed hippocampus and amygdala were hyperintense to the brain parenchyma on T2W and FLAIR images, consistent with inflammation and/or edema. There was contrast enhancement of the membranous tissue in the cystic lesion (Fig. 1D, 1F). The CSF collected from the cerebellomedullary cistern was provided for cytology and bacterial cultures. The number of total nucleated cells was less than 1 cell/$\mu l$, and a microbial culture of the CSF yielded negative results. Differential diagnoses included meningioma and intracranial cysts such as epidermoid cysts, ependymal cysts, and choroid plexus cysts. After consultation with the owner, surgical removal of the cyst was elected.

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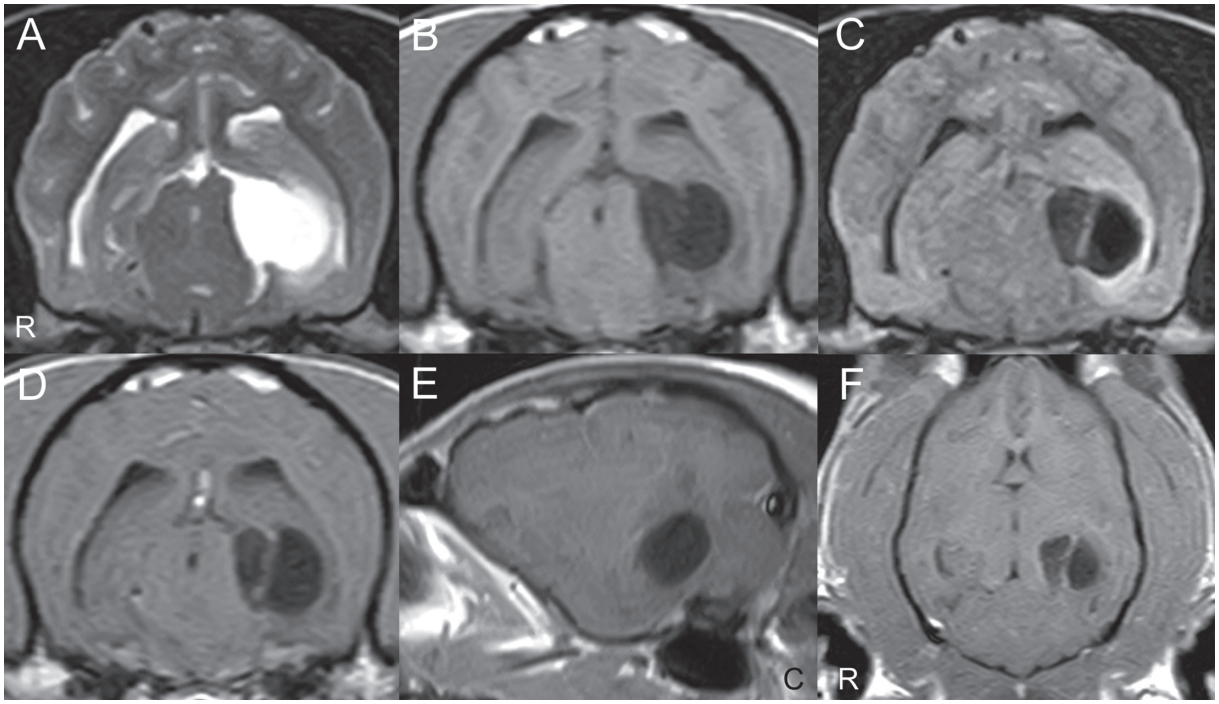


**Fig. 1.** Transverse (A–D), parasagittal (E), and dorsal (F) magnetic resonance images of the brain. The intracranial cyst was hyperintense to the brain parenchyma on a T2-weighted image (A) and hypointense on a T1-weighted image (B). The cyst compressed the mesencephalon, hippocampus, and amygdala, which were hyperintense to the brain parenchyma on a T2W-fluid attenuated inversion recovery image (C). There was weak contrast enhancement of the membranous tissue in the cystic lesion (D, F). R: right, C: caudal.

Levetiracetam (E Keppra; Otsuka Phramaceutical Corp., Tokyo, Japan, 28.8 mg/kg PO q12 hr) was started 3 days before surgery. Left rostrotentorial craniotomy was performed. Intraoperative ultrasonography was performed to locate the cyst. The left parietal lobe was retracted from the tentorium cerebelli to allow for visualization of the cyst. The cyst wall was incised and fluid drained. The intracystic tissue bled easily. The surgical view was ensured by use of a suction tube and neurological pads. The cyst wall was cauterized by bipolar forceps and completely removed by blunt dissection. During intraoperative observations under a surgical microscope, there was no identifiable communication between the cyst and ventricular cavities. A histological examination revealed the collapsed redundant tissue composed of fibrovascular strands with mono-layered, cuboidal epithelium that was occasionally elevated in small papillary projections, which were very similar to the normal choroid plexus (Fig. 2). The findings were consistent with a choroid plexus cyst in humans. There were no perioperative complications. The dog was discharged 3 days after surgery. Zonisamide (3.7 mg/kg, PO, q12 hr), prednisolone (Predonine; Shionogi & Corp., Tokyo, Japan, 0.5 mg/kg, PO, q24 hr), and cephalexin (Cefaclear; Kyoritu Seiyaku Corp., Tokyo, Japan, 22 mg/kg, PO, q12 hr) were added post-surgery. The administration of cefalexin and prednisolone was discontinued 10 days after surgery. The administration of zonisamide was also discontinued 20 days after surgery. Follow-up MRI studies were performed 3 and 12 months (Fig. 3) after surgery. There was no recurrence of clinical signs or cyst formation 18 months after surgery.

To the best of our knowledge, this is the first case report of an intracranial ectopic choroid plexus cyst in a dog. There have only been two previous case reports of choroid plexus cysts in dogs, both of which were located in the fourth ventricle [1, 7]. The two dogs had clinical signs of scratching, fly biting, or disequilibrium [1, 7]. Choroid plexus cysts have been found in humans in each of the ventricles, and most frequently originated from the lateral ventricles [14]. Ectopic choroid plexus cysts are even rarer conditions and located in the intracranial, spinal, and sacral canals in humans [4, 11, 15, 20].

The etiology of a choroid plexus cyst currently remains unknown; however, various theories have been proposed, such as active fluid secretion from the cyst wall, osmotic gradients following minor hemorrhage, and “ball-valve” effect [12, 19, 25]. Some cysts have been linked to a post-traumatic or inflammatory etiology [2, 9]. In our case, active fluid secretion from choroid plexus tissue appeared to have resulted in the continuous enlargement of the cyst, leading to compression and irritation of the mesencephalon, hippocampus, and amygdala. Compression of these structures was correlated with a delay in postural reactions in the right pelvic limb and status epilepticus in this dog.

Differential diagnoses for intracranial cysts include meningioma, arachnoid diverticula, epidermoid cysts, dermoid cysts, ependymal cysts, porencephalic cysts, and choroid plexus cysts. The imaging characteristic of arachnoid diverticula was hyperintense fluid-filled structure on T1W images, which was hyperintense on T2W images and suppressed with FLAIR images. No contrast of the cyst wall was observed [18]. Most epidermoid cysts reported have been located in the cerebellopontine and medullary angle, and the MRI characteristics were similar to those of CSF on T1W and T2W images [3, 18, 22]. The epidermoid

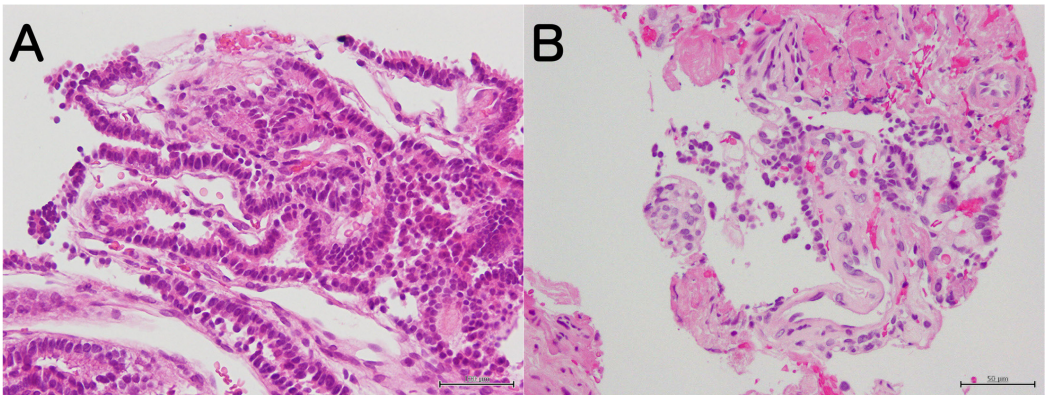


**Fig. 2.** Histopathology of the excised papillary tissues. The excised papillary tissues comprised mono-layered, cuboidal epithelium, which resembled the normal choroid plexus. bar=100 $\mu$m (A). The collapsed redundant tissue comprised fibrovascular strands with mono-layered, cuboidal epithelium. bar=50 $\mu$m (B). Hematoxylin and eosin stain.

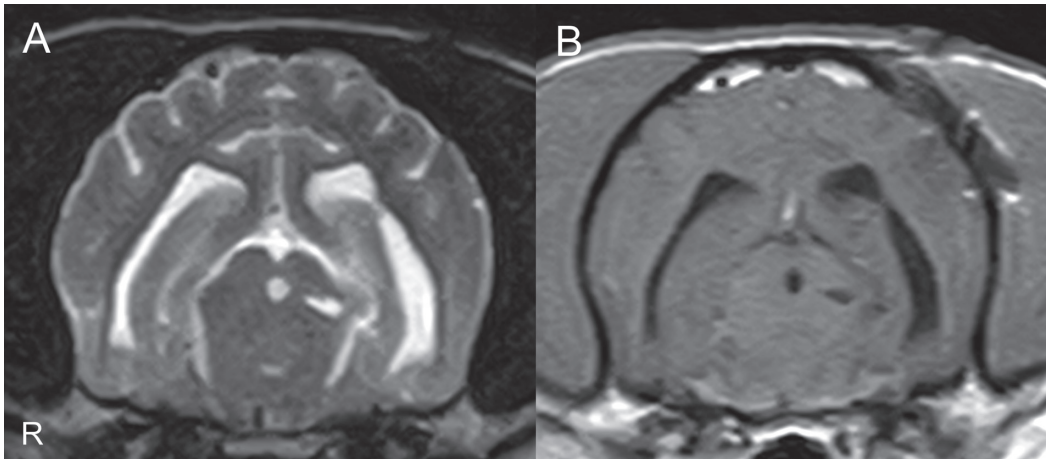


**Fig. 3.** Transverse magnetic resonance images of the brain 12 months after surgery. A small fluid-filled region, hyperintense to the brain parenchyma on a T2-weighted image (A) and hypointense on a T1-weighted image (B), was noted in the mesencephalon, most likely due to surgical insult. Recurrence of the intracranial cyst was not observed. R: right.

cyst in a dog has been described as showing a typically incomplete suppression of FLAIR, and thin contrast enhancement of the cyst wall could be observed [18]. Most intracranial arachnoid diverticula and epidermal cysts were incidental findings because the cyst showed slow growth. The MRI appearance of a dermoid cyst was a hyperintense signal on T1W and T2W images, and no contrast enhancement of the cyst wall was observed [18]. Intracranial dermoid cysts were associated with an obstructive hydrocephalus because of their locations, such as in the medulla and cerebellar peduncle [8, 23]. There was a case report of intracranial ependymal cyst in a dog [24]. The MRI characteristics of ependymal cysts were similar to those of CSF on T1W and T2W images [24]. Histologically, it consisted of a layer of glial cells covered multifocally by epithelial cells. Previous case reports of choroid plexus cysts in humans and dogs showed that the lesion was hyperintense to the brain parenchyma on T2W images and hypointense on T1W images, and contrast enhancement of the wall was observed [1, 10].

It was difficult to diagnose the intracranial cyst with an ectopic choroid plexus by imaging studies alone, and therefore, histological examination was required for a definitive diagnosis. The histological characteristics of the cyst were consistent with those of previously reported choroid plexus cysts in humans [6, 21]. Since the cyst was located outside the ventricular system and did not appear to communicate with the ventricles, an ectopic choroid plexus cyst was diagnosed. The membranous tissue in the cystic lesion was hyperintense to the brain parenchyma on T1W post-contrast enhancement and was confirmed to be the choroid plexus by histology. This contrast enhancement of the cyst may result from blood brain barrier disturbances. Flow-cine MRI techniques are useful for assessing the flow characteristics of CSF and may differentiate various intracranial cysts [5].

Treatments for intracranial cysts in humans include cyst fenestration, ventriculocystoperitoneal shunting, stereotactic puncture, and surgical resection [13, 16, 17]. In our case, surgical excision was selected because the cyst was accessible and there was a possibility of establishing a definitive diagnosis. There was no recurrence of the ectopic choroid plexus cyst 18 months after surgery, indicating that surgical removal is the treatment of choice and appears to be curative.

This case report describes the MRI findings and successful surgical resection of an ectopic choroid plexus cyst in a dog. Although ectopic choroid plexus cysts are very rare, they need to be considered in the differential diagnosis of intracranial cysts in dogs.

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