

Microcystic Meningioma of the Fourth Ventricle in a Dog

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ABSTRACT. A 5-year-old female cross-breed dog was presented with a 1-month history of progressive changes in the posture of the head and in the gait. At neurological examination the dog showed a central vestibular syndrome lateralized to the left. MRI showed a space occupying lesion within the fourth ventricle, characterized by iso- to hypointensity in T1 and hyperintensity in T2 with a heterogeneous contrast uptake. Histologically, a neoplasia composed of meningothelial cells forming compact whorls with slight atypia, and stellate cells delimitating microcysts containing eosinophilic fluid was observed. Neoplastic cells were positive for vimentin and negative for GFAP and FVIII. A diagnosis of intraventricular microcystic meningioma was achieved. Intraventricular meningiomas in dogs are rarely encountered and reports of meningiomas within the fourth ventricle have not yet been described. Although choroid plexus tumor is the most frequent neoplasia localized in the fourth ventricle, intraventricular meningioma should be included in the differential diagnoses.

KEY WORDS: canine, central nervous system tumors, intraventricular meningioma, microcystic meningioma.

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Meningiomas are the most common canine intracranial tumors and differently from human neuro-oncology are frequently classified as atypical meningioma (grade II) with a poorer therapeutic response [14]. Meningiomas involve most commonly the anterior half of the dorsal surface of the brain near the falx [11]. Other common locations are *tentorium cerebelli*, ventral or lateral aspect of the brainstem, mainly at hypothalamus and optic chiasm level, and other external surfaces of the brain with a typical extra-axial growth pattern [9, 11]. Although the intraventricular location involving the *tela choroidea* of the third ventricle represents a common site for meningiomas in cats [15], it is rare in dogs and the presence of meningiomas in the fourth ventricle has not yet been described in the literature. A secondary involvement of the fourth ventricle by a meningioma consequent to local extension has been described in a dog [6]. In human beings, intraventricular meningiomas are rare and meningiomas of the fourth ventricle are exceptional [4].

Histologically, meningiomas in animals are classified as meningothelial, fibroblastic, transitional, psammomatous, angiomatous, papillary, granular cell, myxoid and anaplastic [5]. Rare reports of cystic and microcystic meningiomas are also described [1, 8, 12, 14].

To our knowledge, no cases of microcystic meningiomas involving the fourth ventricle in dogs have been described so far. This report describes the clinical, neuroradiological and neuropathological findings of a dog with a primary meningioma of the fourth ventricle with histological features suggestive of microcystic subtype.

A 5-year-old female cross-breed dog was presented with a 1-month history of progressive changes in the head posture, frequent fallings, circling to the left side and excessive anxiety. Neurological evaluation revealed wide-based stance, head tilt and pleurothotonus to the left side, and vestibular ataxia characterized by drifting, falling and circling to the left. The proprioception was slightly decreased on the left thoracic and pelvic limbs, whereas was normal on the right side. Cranial nerve evaluation evidenced a vestibular strabismus of the left eye when the head was lifted up and put into a straightforward direction. Spinal reflexes were unremarkable. The lesion was localized on the left side of the central vestibular system. Differential diagnoses included space occupying lesions such as neoplasia or cysts, inflammatory diseases, anomalies and degenerative diseases. Blood tests and thoracic radiographs were normal.

Magnetic resonance imaging (MRI) of the neurocranium and cranial cervical region were performed using a 0.2 Tesla magnet (VetMR[®], Esaote, Genoa, Italy) pre- and after contrast administration at the dosage of 0.15 mmol Gadolinium/kg BW (Magnevist[®]). The sequences included T1- and T2-weighted Spin Echoes (SE T1, SE T2) in sagittal and transverse orientation. Post contrast sequences included a SE T1 in sagittal, transverse and dorsal planes and a dorsal Fluid-Attenuated Inversion Recovery (FLAIR) sequence. The cervical spine was evaluated post contrast by means of a sagittal T1- and T2-weighted SE. A space occupying lesion within the fourth ventricle with slight lateralization to the left side was detected. It showed an irregular globular form and sharply delineated margins. Compared to the brainstem, the lesion appeared iso- to hypointense in T1 (Fig. 1), hyperintense (slightly inhomogeneous) in T2 (Fig. 2), with inhomogeneous, peripherally pronounced contrast uptake.

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On the post contrast FLAIR, the contrast enhancing areas were more hyperintense than in T1; the other areas were iso to minimally hyperintense to normal brain tissue. Minimal edema, characterized by focal areas of increased signal intensity in T2, hypointense in T1 without contrast uptake, was detected in the cerebellar medulla dorsally adjacent to the lesion. Mild mass effect displacing the cerebellum dorsally and the medulla oblongata ventrally was present. The lateral ventricles and the third ventricle appeared moderately distended. At the level of the cervical spinal cord, from mid C2 to end C5, the central canal was dilated and lesion was interpreted as a secondary syringohydromyelia (Fig. 2). Differential diagnoses for the lesion in the fourth ventricle included firstly neoplasia, such as choroid plexus tumor, ependymoma, hamartoma, and intraventricular glioma. The dog was euthanized upon owner's request because of poor prognosis.

A complete necropsy was performed and lesions were limited to the brain that showed a slight herniation of the caudal portion of the cerebellar vermis. After fixation in 10% neutral buffered formalin solution, transverse sections of the brain revealed the presence of a whitish, not homogeneous mass within the fourth ventricle. The mass appeared globular, with irregular margins and compressing the cerebellum and medulla oblongata. The cut surface showed solid tissue areas alternated with a cribriform appearance of the tumor due to the presence of barely visible cyst formations (Fig. 3). The sampled tissue was routinely processed for histology and sections were stained with hematoxylin and eosin, periodic acid-Schiff (PAS), Luxol fast blue and Goldner trichrome methods. Selected sections were also stained immunohistochemically with antibodies against glial fibrillary acidic protein (GFAP; 1:100, Dako, Carpinteria, U.S.A.), vimentin (1:100; Novocastra Laboratories Ltd, Newcastle upon Tyne, U.K.), pancytokeratin (CK; 1:100, Novocastra Laboratories Ltd, Newcastle upon Tyne, U.K.), and factor VIII-related antigen (FVIII; 1:100, Novocastra Laboratories Ltd, Newcastle upon Tyne, U.K.). At histological examination a well demarcated, not encapsulated neoplasia developing within the stroma of the choroid plexus of the fourth ventricle was evident. The neoplastic tissue was surrounded by normal ependymal cells and was characterized by a loosely microcystic appearance due to the presence of extracellular spaces of variable shape and size, delimited by cytoplasmic processes of stellate neoplastic cells (Fig. 4). The cells had elongated processes, oval nuclei, finely stippled chromatin and indistinct nucleoli; moderate anisocytosis and anisokaryosis, and 1–2 mitoses per high power field were observed. The tumor cells were supported by a delicate fibrovascular stroma. More solid areas showed small typical meningothelial whorls (Fig. 5). Larger cystic structures appeared empty or filled with scant, weakly eosinophilic and PAS-negative material. Rare erythrocytes, lymphocytes, and hemosiderocytes were also observed. Surrounding the neoplastic tissue, large perivascular inflammatory infiltrates mainly composed of lymphocytes, macrophages and clusters of hemosiderocytes were

noted. Neoplastic cells were strongly vimentin-positive, whereas they were weakly and not uniformly labeled with anti-pancytokeratin antibody. Both neoplastic cells and ependymal cells were negative with GFAP and FVIII.

The histological and immunohistochemical features of the neoplasia were consistent with an intraventricular microcystic meningioma. Depending on the mass localization, a choroid plexus tumor was considered as most likely by neuroradiological examination. Indeed, the most common tumors of the fourth ventricle in dogs are choroid plexus tumors (papilloma or carcinoma). Choroid plexus tumors appeared as intra-axial masses showing hyperintensity or with mixed isointensity and hyperintensity on all 3 pulse sequences. Also meningiomas appeared as isointense or hyperintense on proton density-weighted images (PDW1) and T2-weighted images (T2W1), but are generally recognizable because of their localization as extra-axial tumors [6, 13, 14]. In our case, the neoplasia showed an iso- to hypointensity in T1 and hyperintensity in T2, with a heterogeneous contrast uptake and histopathology was necessary for a definitive diagnosis. However, MRI findings in our case are comparable to human intraventricular meningiomas [7].

Histologically, the neoplasia of our study was characterized by cells with elongated processes giving a microcystic appearance, associated with occasional meningothelial whorls. These morphological features are suggestive of microcystic subtype of meningioma. Neither metastases, nor liquor spreading were observed. Cells reacted positively with vimentin and negatively with GFAP and FVIII, accordingly to the literature [2, 8]. The negativity to FVIII excluded a vascular origin of the tumor. Microcystic meningioma is not included in the domestic animal classification of meningiomas [5], however it is described in dogs [8] and is well described and classified in human beings. Cystic meningioma has also been described in dogs [1, 12], but was characterized by a large central cystic area surrounded by solid areas with features of papillary, meningotheliomatous or transitional meningioma, differing from microcystic meningioma. In those cases, cysts were supposed to originate from tumor necrosis, tumor cerebrospinal fluid production or imbibition [1].

Arachnoid cap cells and trabecular arachnoid cells are supposed to originate microcystic meningioma in human beings [10] and small whorls of meningothelial (arachnoid) cells (forming the *tela choroidea*), which are normally present in the choroid plexus, could originate the intraventricular meningiomas [3, 7]. In our case, the tumor clearly originated from the choroid plexus of the 4th ventricle.

Intraventricular meningiomas are common in cats and also meningiomas of the fourth ventricle have been described in this species [15]. In human beings, the primary occurrence of meningiomas in the ventricular system without dural attachment is rare [7]. Metastasis through hematogenous route or spread via the cerebrospinal fluid have been reported in human beings with intraventricular meningiomas, both in cases with benign and atypical histo-

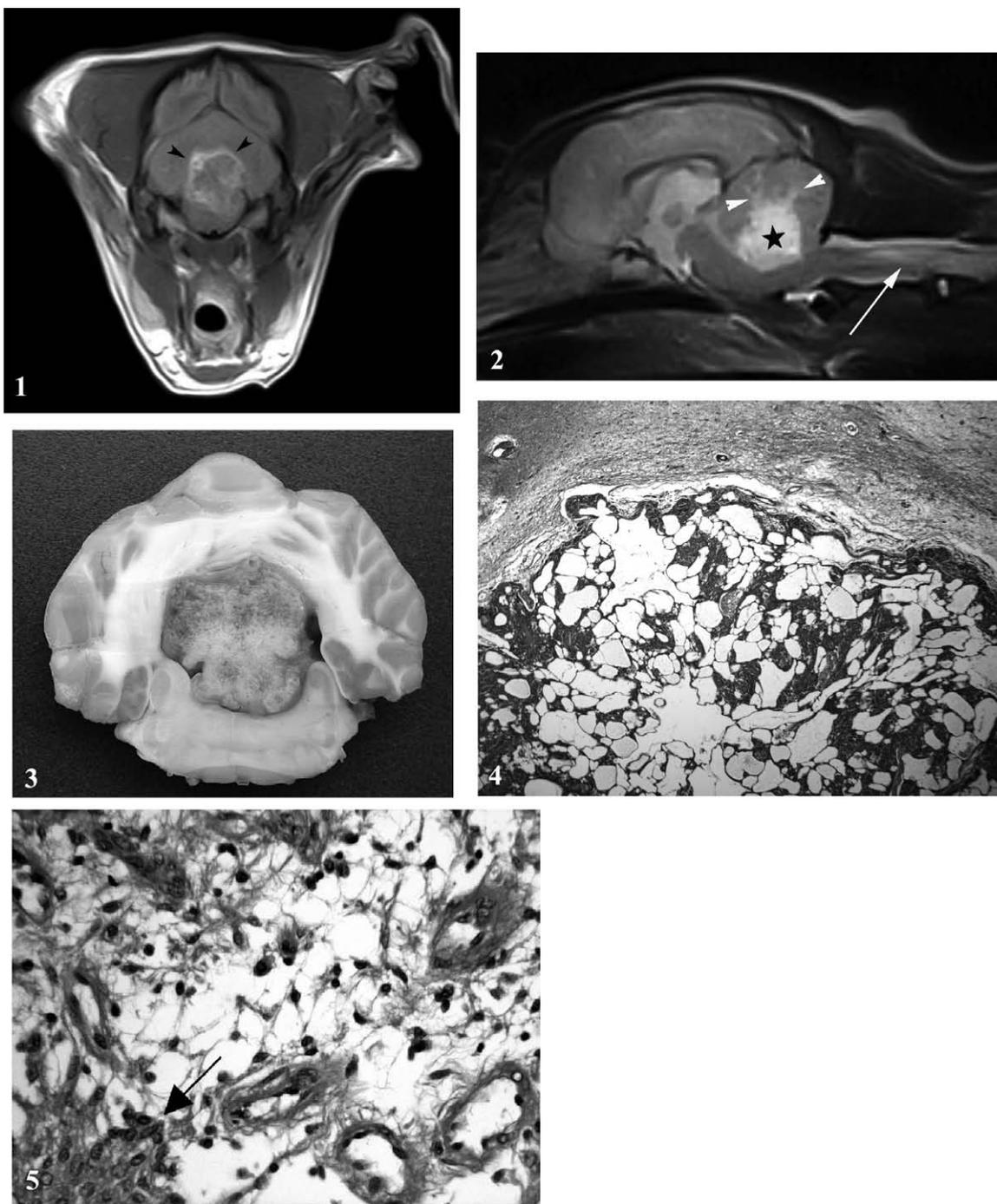


Fig. 1. Transverse, contrast enhanced MRI image, T1-weighted. A space occupying lesion within the fourth ventricle, isointense compared to the brainstem with inhomogeneous, peripherally pronounced contrast uptake (*arrowheads*).

Fig. 2. Sagittal MRI image, T2- weighted. A hyperintense neoplastic mass occupying the fourth ventricle is evident (*asterisk*), associated with focal areas of increased signal intensity dorsally to the lesion interpreted as edema (*arrowheads*). Dilatation of the central canal of the cranial cervical spinal cord is also evident (*arrow*).

Fig. 3. Transverse section of fixed brain. A neoplastic mass expanding the fourth ventricle and compressing the brainstem and cerebellum is evident. The neoplasia shows an irregular appearance with solid and cribriform areas.

Fig. 4. An intraventricular neoplastic proliferation compresses the cerebellar white matter. The neoplasia is composed of cells forming cystic spaces and solid areas. Hematoxylin and eosin stain; $\times 32$ magnification.

Fig. 5. Neoplastic stellate cells form multiple and variable sized empty cysts. A nest of meningothelial cells is evident (*arrow*). Hematoxylin and eosin stain; $\times 400$ magnification.

logical features [4]. No previous reports of fourth ventricle meningioma have been described in dogs, and hence this type of tumor should be included in the differential diagnoses in cases of intraventricular neoplasms. The occurrence of unusual phenotypes, such as the microcystic subtype, should also be considered in this location.

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