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CASE REPORT

Use of a telovelar approach for complete resection of a choroid plexus tumor in a dog

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Abstract

Objective: To describe a telovelar approach to the fourth ventricle for excision of a choroid plexus tumor within the ventricle.

Animal: A 3-year-old entire male Chihuahua.

Study design: Case report

Methods: A 3-year-old dog with two-month history of progressive vestibular signs and subdued mentation was diagnosed with a fourth ventricle tumor. Gross total resection of the tumor was achieved through a telovelar approach to the fourth ventricle.

Results: Complete removal of the tumor was confirmed on immediate postoperative MRI. The dog recovered from the surgical procedure without complications, displaying some neurological deficits as preoperatively. His neurological examination was normal 2 weeks after surgery and remained so until the time of writing this case report (28 months) without additional treatment.

Conclusion: The telovelar approach allowed complete excision of a choroid plexus tumor located in the fourth ventricle of the dog reported here.

1 | INTRODUCTION

The treatment of choroid plexus tumors is challenging both in human and veterinary medicine. Choroid plexus tumors arise from the epithelium of the choroid plexus and account for approximately 7% to 10% of primary brain tumors in dogs.[1,2] Treatment protocols have not been established in veterinary medicine, in contrast to human medicine, in which surgical excision with or without adjunctive radiotherapy (depending on gross resection of the tumor) is considered the most effective treatment option.[3] When these tumors affect the fourth ventricle in human patients, a transvermian or a telovelar approach is commonly chosen to access the ventricle and allow resection.[4] The telovelar approach requires incision of the tela choroidea,[4,5] which is a layer of pia matter and ependymal cells forming the roof plate that covers the fourth ventricle[6,7] (Figure 1). The telovelar approach provides a greater angle of exposure and is less traumatic compared to the transvermian approach in humans.[4] Suboccipital craniectomy is well described in veterinary medicine for accessing the caudal fossa; however, detailed descriptions of the surgical approach to the fourth ventricle have not been reported in veterinary medicine. The aim of this case report is to describe the telovelar approach to the fourth ventricle for resection of

a choroid plexus tumor in a dog and discuss its utility for treatment of choroid plexus tumors located in the fourth ventricle in dogs.

2 | MATERIALS AND METHODS

A three-year-old male entire Chihuahua presented for investigation following a two-month history of obtunded mentation, slowly progressive vestibular ataxia and right-sided head tilt. General physical examination was within normal limits. Neurological examination showed obtunded mental status, mild right-sided head tilt and mild vestibular ataxia with circling towards the right. The postural reactions were delayed in all limbs with right thoracic and right pelvic limbs being more affected compared to the left limbs. Cranial nerve examination revealed a bilaterally absent menace response and bilateral ventrolateral positional strabismus. The remainder of the cranial nerve examination was normal. Based on the neurological examination, a multifocal neuroanatomical localization to the structures of the caudal fossa, including cerebellum and medulla oblongata, was suspected.

Hematology and comprehensive biochemistry profiles were within normal limits. Thoracic radiographs had been performed by the primary care veterinarian and were reported as normal. Magnetic resonance imaging (MRI) of the brain (1.5 T HDE General Electrics) was performed and revealed an intraventricular oval to "J" shaped midline mass at the level of the fourth ventricle. The mass was heterogeneously hyperintense to the gray matter in T2W images and was iso- to hyperintense to the cerebral gray matter in T1W images. There was marked diffuse homogenous contrast enhancement following intravenous gadolium administration (Figure 2). The mass was causing marked compression of the surrounding structures resulting in ventral displacement of the medulla oblongata and dorsal displacement of the cerebellum. There was subsequent marked obstructive hydrocephalus with enlargement of the lateral and third ventricles, foramen magnum cerebellar herniation, and presence of cervical syringohydromyelia over the C2–C4 vertebral bodies. The latter signs were consistent with raised intracranial pressure. The supraoccipital bone appeared subjectively thinner and hypoplastic. Given the location of the mass and MRI characteristics, a choroid

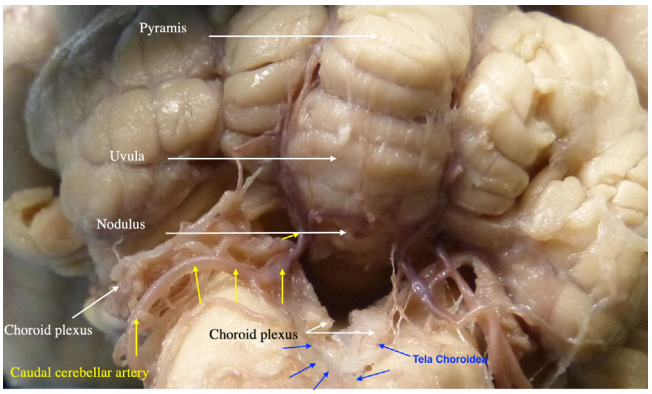

FIGURE 1 Tela Choroidea is a layer of pia matter and ependymal cells. When capillary vessels develop on the tela choroidea, they finally form the choroid plexus. (courtesy and property of Dr Vicente Aige-Gil Universidad Autónoma de Barcelona)

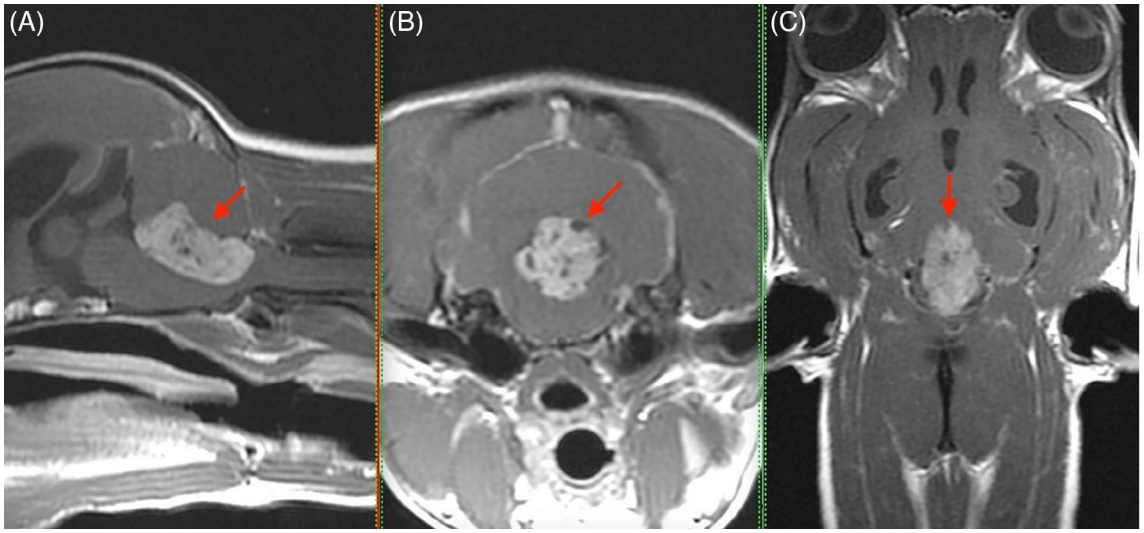

FIGURE 2 Preoperative magnetic resonance imaging (MRI). Post contrast T1-weighted images in the sagittal (A) transverse (B) and dorsal (C) planes showing the mass (red arrow)

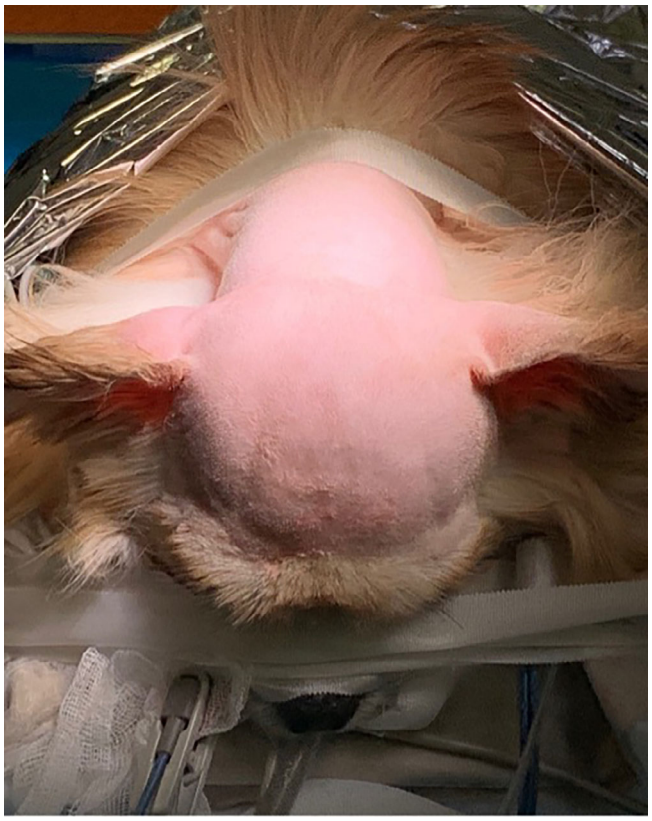

FIGURE 3 Surgical position of the dog. Note the flexion of the head supported by adhesive tape bands to assure the position in flexion during surgery. A noncollapsing endotracheal tube was used to prevent compromise of the airway

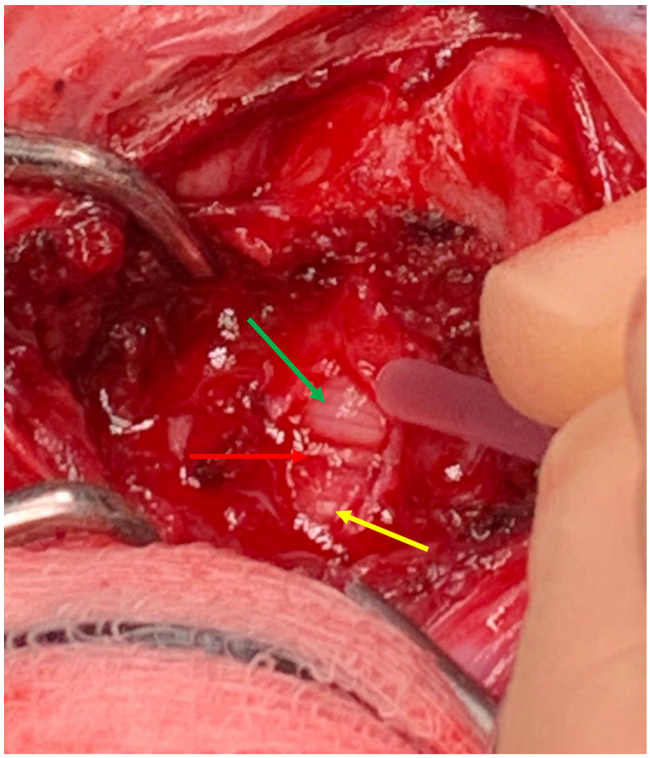

FIGURE 4 Durotomy and exposure of caudal cerebellar vermis (pyramis, vermis; green arrow), tela choroidea involving the choroid plexus tumor protruding underneath the cerebellar vermis (red arrow), and dorsal C1 spinal cord segment compressed by the tumor (yellow arrow)

plexus carcinoma or papilloma were considered the most likely differential diagnosis; however, an ependymoma or other extra axial tumors such as meningioma or lymphoma could not be ruled out. Cerebrospinal fluid collection was not performed due to the presence of the mass and MRI features consistent with increased intracranial pressure. Further imaging of the spinal cord and the abdomen for metastasis was not performed due to financial limitations.

3 | TREATMENT

Treatment with mannitol 0.5 g/kg IV every 8 hours and prednisolone 0.5 mg/kg once daily were administered for reducing the presumed increased intracranial pressure until surgical excision, 2 days following MR imaging. Surgical excision of the choroid plexus mass was performed using an approach similar to the telovelar approach described in human medicine.[5] The dog was positioned in ventral recumbency with the head ventroflexed at 90°s to the spine (Figure 3). A noncollapsing endotracheal tube was used to avoid compression of the airway due to the flexion of the head. Magnification loupes were used by the primary surgeon. The skin up to the parietal bone rostrally, temporal bone ventrally and the cranial dorsal cervical area caudally were aseptically prepared. A midline incision extending from two centimeters cranial to occipital protuberance to the caudal aspect of the spinous process of C2 was made with a number 10 scalpel blade. The subcutaneous fat was bluntly incised on the midline, the cervicoauricularis, splenius capitis and rhomboideus muscles were incised centrally, and these were retracted laterally. The remaining muscle attachments were gently removed from the occipital bone using a periosteal elevator. The occipital bone appeared like a thin sheath of periosteum and was easily removed with bone curettes hence suboccipital craniectomy with a pneumatic drill was not necessary. When adequate exposure to the caudal fossa was achieved, the dura mater was incised with a number 15c scalpel blade at the level of the atlas and the incision was extended rostrally to the uvula of the cerebellum. The dura mater was then retracted laterally with stay sutures (Prolene 6/0). The tela choroidea was identified as a thin, membranous layer encapsulating the caudal portion of the mass (Figure 4). The mass was located within the fourth ventricle, ventral to the

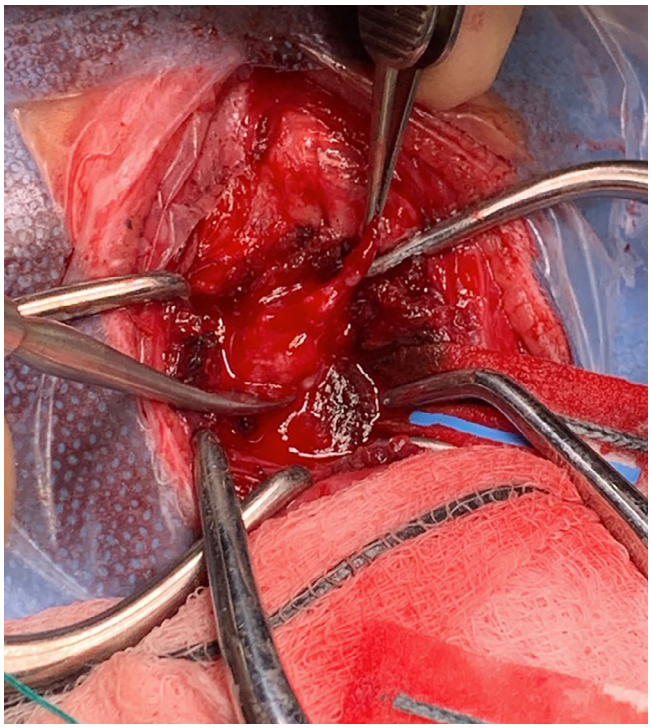

FIGURE 5 Removal of the main portion of the tumor after detachment from the surrounding tissues

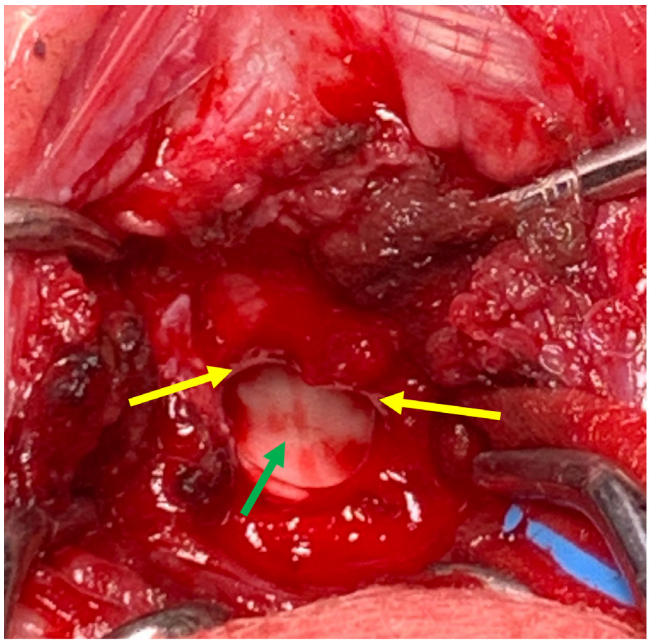

FIGURE 6 Intraoperative image after tumor removal. Romboid fossa could be identified (green arrow), as well as remaining tela choroidea (yellow arrow)

cerebellum and dorsal to the medulla and the C1 spinal cord segment. The tela choroidea was elevated with corneal forceps and bluntly incised with a mosquito forcep. The incision was continued rostrally, with ophthalmic triangular swabs and neurosurgical sponges, to the level of caudal medullary velum and rostral medullary velum just ventral to the nodulus of cerebellum. The use of triangular swabs and neurosurgical sponge minimized the injury of surrounding tissues and provided concurrent hemostasis. Since the incision was performed on structures with minimal vascularity, hemorrhage was easily controlled without electrocautery. The incision of the tela choroidea detached the tumor from the roof of the fourth ventricle and ventral aspect of cerebellum. The dissection of the mass from the wall of fourth ventricle was continued laterally. Mild hemorrhage was controlled with absorbable oxidized regenerated cellulose (Fibrillar, Ethicon) and bipolar electrocautery where possible. A large portion of the mass detached from the surrounding tissues and was removed (Figure 5). Following removal of the first major portion of the mass, further inspection of the rostral aspect of the fourth ventricle revealed two smaller lateral portions of the tumor. Mild dorsal elevation of the cerebellum provided more space for the instruments and a larger surgical field. The remaining portions of the mass were gently retracted caudally with corneal forceps and when completely detached, were removed. Additional minor hemorrhage was controlled with absorbable oxidized regenerated cellulose and the surgical field was lavaged with cold saline. A complete dorsal view of the rhomboid fossa was achieved with no evidence of further neoplastic tissue (Figure 6). The dissected tela choroidea was not sutured. The dura mater was sutured with 6/0 absorbable suture material (Monocryl 6/0) in a continuous pattern. Closure of the muscle layer and skin was performed with continuous patterns using absorbable suture material (Monocryl 3/0). The mass was submitted for histopathological examination.

4 | RESULTS

Postoperative MRI was performed immediately after surgery and showed that the mass had been excised completely and the fourth ventricle was filled with fluid (Figure 7). The cerebellum was already repositioned to its normal anatomical site and the diameter of the cranial cervical syringohydromyelia was subjectively smaller compared to the preoperative images.

The dog recovered uneventfully from general anesthesia and was hospitalized in the intensive care unit of the hospital for the following 2 days. Analgesia was provided with intravenous 0.2 mg/kg methadone every 4 hours and 10 mg/kg paracetamol every 8 hours. One day postoperatively the dog was neurologically similar compared to the preoperative period, having ambulatory ataxia and mild right-sided head tilt. The following day, the ataxia had

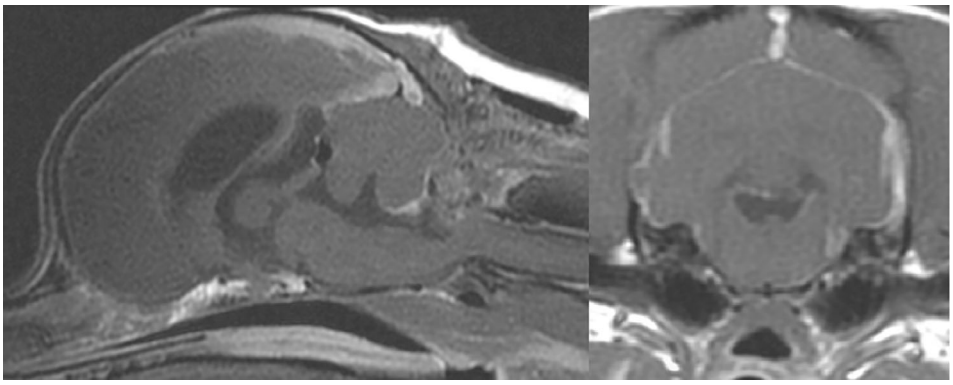

FIGURE 7 Immediate postoperative magnetic resonance imaging (MRI). Post contrast T1-weighted images in sagittal (left) and transverse (right) planes. No evidence of tumor remnants was detected

improved but the degree of head tilt was unchanged. The postural reactions were delayed but they were improved compared to presentation. The menace response was intermittently absent in both eyes; however, improvement was apparent compared to the preoperative period. The dog was discharged 3 days postoperatively, still having mild vestibular ataxia and mild right-sided head tilt, but was showing continuous improvement of neurological signs. The dog received oral prednisolone 0.5 mg/kg once daily for 10 days which was then reduced 0.25 mg/kg once daily for the following 5 days when it was discontinued. Omeprazole 1 mg/kg once daily for 15 days and paracetamol 10 mg/kg every 8 hours for 10 days were administered orally.

On histopathology, the mass was described as a neoplasm of epithelial phenotype with a characteristic papillary growth. The cells showed large amount of light basophilic cytoplasm, well defined cell boundaries, parabasal round nucleus with finely stippled chromatin and single large eosinophilic nucleolus. There was a moderate degree of atypia and increased mitotic index (9 mitoses × 10HPFs). Based on the histopathological characteristics of moderate atypia and increased mitotic index, a choroid plexus carcinoma was considered more likely than a papilloma.

Postoperative recheck 2 weeks after surgery revealed completely resolved vestibular ataxia and head tilt. The postural reactions and cranial nerves were also within normal limits and the dog was deemed neurologically normal. The dog remained neurologically normal at the time of writing of this case report, 28 months after surgery. A malignant choroid plexus tumor is considered less likely than a papilloma given the prolonged survival time of the dog and no adjuvant treatment.

5 | DISCUSSION

To the authors' knowledge this is the first case report describing the details of the approach to the fourth ventricle via a suboccipital craniectomy. Although this approach has not been specifically described previously, it may have been performed to remove masses in the fourth ventricle in previous reports without the explicit description of the tela choroidea, as it is extremely delicate in the dog.[8,9] The telovelar approach is a vermian sparing procedure utilizing dissection through avascular planes. This approach commonly requires only incision of the tela choroidea to gain access to the caudal half of the fourth ventricle[10] (Figure 8). In human medicine, several case series have demonstrated the utility of the telovelar approach in patients with 4th ventricle tumors.[4,5,10,11]

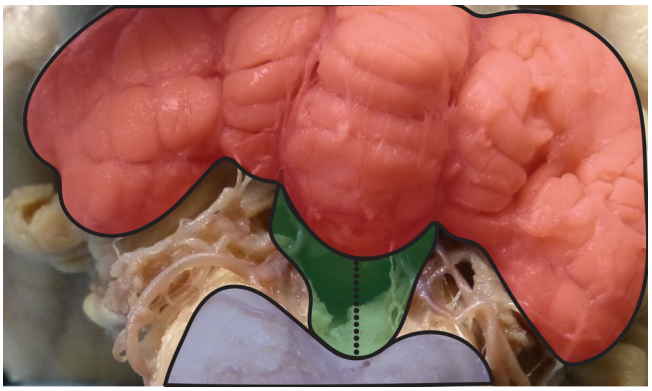

FIGURE 8 Schematic illustration of telovelar approach. The green area is a colorful illustration of the tela choroidea which is the caudal end of the fourth ventricle between the cerebellum (red area) and brainstem (blue area). The dotted line represents the incision of the tela choroidea after a suboccipital craniectomy

In humans, lateral retraction of cerebellar tonsils following blunt dissection of the cerebellotonsilar and uvulotonsilar space is necessary for identifying the tela choroidea and caudal medullary velum.[5] As dogs do not have cerebellar tonsils, this step is not required. Transvermian and telovelar are the two approaches of choice in human medicine for accessing the fourth ventricle.[4] A cadaveric study in humans demonstrated that the telovelar approach provides greater angle of exposure to the fourth ventricle in all planes, apart from vertical angle to the rostral aspect of the fourth ventricle.[4] The telovelar

approach was developed on the premise that accurate dissection along the natural avascular planes will avoid injury to the important structures in this area minimizing morbidity.[12] In a transvermian approach, access to the fourth ventricle is gained by splitting of the inferior vermis or with partial removal of the cerebellar hemisphere.[5] The injury of cerebellum frequently leads to cerebellar mutism.[5] After taking into consideration these factors and based on the high neovascularization of choroid plexus tumors, a telovelar approach was chosen over a transvermian in our dog.

Treatment protocols for choroid plexus tumors have not been established in veterinary medicine. In human medicine, regardless of the choroid plexus tumor type, a gross total resection is crucial for treatment.[3] Adjunctive radiotherapy is used in choroid plexus carcinomas when complete resection of tumors is difficult to achieve due to the neovascularization of the tumor.[13,14] Complete excision of the tumor is associated with increased survival times.[3,14] A report on another dog with fourth ventricle choroid plexus papilloma that was treated medically with prednisolone, acetazolamide and glycerine survived for 15 months. However neurological deficits persisted throughout the dog's life.[15] The survival time of another dog following surgical resection of a choroid plexus papilloma from the lateral ventricle through a transcallosal approach was at least 9 months.[16] Treggiari et al. reported a median survival time of 3 years in dogs with infratentorial tumors.[17] Two of the dogs included in that study were diagnosed with a choroid plexus tumor. In our case report, the dog fully recovered without recurrence of any neurological deficits at the time of writing this case report. We hypothesize that complete excision of the tumor using minimally traumatic technique resulted in the favorable outcome.

Two case reports of suboccipital craniectomy for removal of choroid plexus cysts from the fourth ventricle were found in the veterinary literature.[8,9] However, neither report described the steps followed for accessing the fourth ventricle following suboccipital craniectomy. Interestingly, De Decker et al. reported difficulties removing the entire cyst due to the adhesions to the surrounding tissues, despite using an ultrasonic aspirator.[8] In our case, the mass was not tightly attached to the surrounding tissues. The absence of strong adhesions enabled complete resection of the tumor as well as concurrent minimal injury to the surrounding structures. It is the authors' belief that the use of the telovelar approach and concurrent lack of tight adhesions between tumor and surrounding tissues contributed to the complete excision of the tumor. The identification and the careful incision of the tela choroidea resulted in atraumatic detachment of the tumor from the nodulus and uvula of the cerebellum. Additionally, the tela choroidea was used as a landmark for dissection of the caudal and rostral medullary velum that further released the tumor from the surrounding structures. This minimized hemorrhage, enabled gentle, atraumatic dorsal displacement of the cerebellum that increased the size of surgical field, and provided better intraoperative visualization for complete resection of the mass. Furthermore, in this case, postoperative neurological deterioration was not observed. We believe that telovelar approach could be used in veterinary medicine for treatment of tumors located in fourth ventricle. The nature of the mass and the degree to which adhesions between the mass and surrounding tissues might impede surgical resection, and whether the telovelar approach would be helpful in such cases, would depend on findings in subsequent similar cases.

No accepted canine grading scheme is currently used and therefore choroid plexus tumors are commonly graded by the WHO human choroid plexus tumor criteria.[2] According to WHO classification system choroid plexus tumors are subdivided as: grade 1 choroid plexus papilloma, grade 2 atypical choroid plexus papilloma, and grade 3 choroid plexus carcinoma. Westworth et al., reported CSF protein levels above 80 mg/dl and presence of drop metastasis are only seen in choroid plexus carcinomas and not in papillomas and they can be useful in differentiation between these tumors in clinical setting.[1] Cerebrospinal fluid collection due to severe mass effect and high risk of further brain herniation could have been fatal in our dog and therefore it was not collected. There was no sign of metastasis in the thoracic radiographs or on the MRI of the brain or on the visualized cranial cervical spinal cord. However, since MR imaging of the entire central nervous system was not performed, drop metastasis in the distal spinal cord could not be ruled out. Final histopathological diagnosis was not achieved in this dog as the histological features represented a papillary neoplasm of epithelial phenotype with a characteristic papillary growth and moderate degree of atypia including increased mitotic index. Additionally, there was not a clear infiltration of the neuroparenchyma, which is normally considered the discriminating element between carcinoma and papilloma of the choroid plexuses.

Presence of more than five mitoses per high-power field, increased cellular density, nuclear pleomorphism, blurring of the papillary pattern, and necrosis are the histopathological characteristics of the choroid plexus carcinoma in human medicine.[18] Reginato et al. reported that N-cadherin immunolabeling was more expressed in grade I than higher grades choroid plexus tumors,[19] however the owner declined immunochemistry in this dog due to financial limitations. Given the fact that the tumor was removed by pulling out from the fourth ventricle and did not have any attachments to the dorsal medulla oblongata or ventral cerebellum, normal tissue was not expected to be present in the samples. However, the

neuropathologist examining the submitted sample finally postulated that there were enough morphological criteria to point towards a final diagnosis of carcinoma over papilloma. Final diagnosis is still open until necropsy can be performed after a dog's death; however, choroid plexus carcinoma is considered less likely based on the prolonged survival without recurrent neurological signs.

There are some limitations in this case report. Due to financial limitations of the owners, MRI of the entire central nervous system and long term follow-up MRI was not performed. Intraoperative collection of CSF might have been helpful in distinguishing whether the tumor was malignant or benign. Since there are no studies comparing different surgical approaches to the fourth ventricle in dogs, the superiority of this technique over others in veterinary neurosurgery cannot be proven. Lastly, due to financial limitations, immunohistochemistry for tumor grading could not be performed. In conclusion, this case report describes the successful surgical removal of a choroid plexus tumor with a surgical approach similar to the telovelar approach used in human neurosurgery and provides detailed technique of the procedures used to access the fourth ventricle after suboccipital craniectomy, for the first time in the veterinary literature.

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CONFLICT OF INTEREST

The authors declare no conflict of interest related to this article.

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