Case Report

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Clinical Feasibility of CT Brain Perfusion in a Dog with Sellar Region Tumor

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Abstract A 10-year-old spayed female Poodle was referred for blindness. On ophthalmic examination, loss of bilateral ocular pupil light reflex, visual loss, and right retinal detachment were confirmed at a local hospital. Magnetic resonance imaging (MRI) of the brain was performed to identify the optic nerve, optic chiasm, and brain disease. A sessile mass centered on the region of the optic chiasm was identified. The mass had iso- to hypointense on fluid-attenuated inversion recovery and T2-weighted images and mildly hypointense on T1-weighted images compared to the gray matter, with strong contrast enhancement. Peripheral edema was also identified. Computed tomography (CT) brain perfusion was performed to obtain additional hemodynamic information about the patient using a multislice CT. CT perfusion showed that the cerebral blood volume in the left temporal lobe region (13.4 ± 1.6 mL/100 g) was decreased relative to the contralateral region (19.9 ± 0.3 mL/100 g). The patient showed decreased appetite and consciousness one week after the CT scan with clinical symptoms worsened. The patient had seizure, tetraparesis, and loss of consciousness. It was euthanized one month later at the request of the owner. This report suggests that CT brain perfusion can provide additional hemodynamic information such as insufficient brain perfusion in sellar region tumor which can help assess potential complications and prognosis and plan treatment.

Key words cerebral blood volume, CT perfusion, dog, sellar tumor.

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Introduction

Sellar region tumor occurs in the sellar region, a small area surrounded by sellar turcica, diaphragm sellae, and superiorly adjacent to important structures including the optic chiasm, hypothalamus, and circle of Willis (2). This small and complex structure makes it difficult to distinguish tumor origin and evaluate prognosis only with imaging information. In humans, a sellar region tumor is typically benign. It can be divided into a functional sellar tumor with endocrine symptoms and a non-functional sellar tumor without hormonal hypersecretion (2). A non-functional sellar tumor is often detected incidentally because it has no clinical symptoms (12). However, it can cause neurological symptoms with large sizes by compressing adjacent nerve and vascular tissues (10). Even In dogs, a non-functional sellar tumor is likely to have neurologic signs secondary to mass effect if it is large enough (5,11).

Diffusion-weighted imaging (DWI), one of the magnetic resonance imaging (MRI) sequences, is more sensitive in identifying ischemic brain damage than conventional pulse sequences. This sensitivity arises from its ability to rapidly detect cytotoxic edema in the brain parenchyma following the onset of ischemic changes (9). Compare to conventional MRI, perfusion-weighted imaging could not directly provide

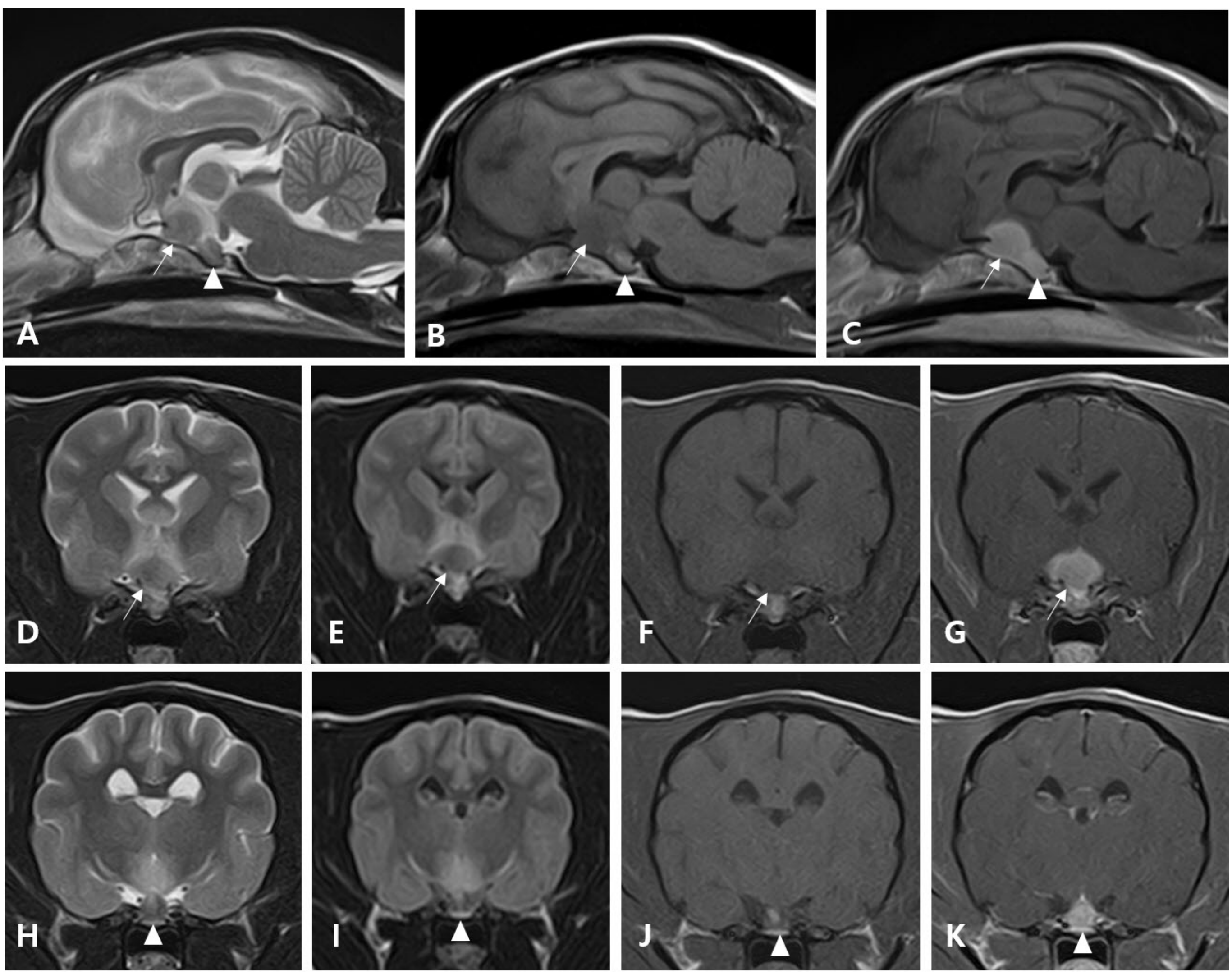

Fig. 1. Sagittal (A-C), axial at the level of the optic chiasm (D-G), and axial at the level of the pituitary gland (H-K) MRI images. These images include T2-weighted (A, D, and H), FLAIR (E, I), T1-weighted (B, F, J), and contrast-enhanced T1-weighted (C, G, K) brain MRI images. The MRI depicts a sessile mass (arrow) centered on the optic chiasm region. The mass appears iso- to hypointense on FLAIR and T2-weighted images. It is mildly hypointense on T1-weighted images compared to the gray matter, with a strong contrast enhancement. Peripheral edema is also evident on the dorsal aspect of the sessile mass. The arrowhead indicates the pituitary gland.

damage and compromise due to ischemic change of parenchyma, although it could provide hemodynamic information of the brain parenchyma, with a decreased cerebral blood volume (CBV) corresponding to diffusion restriction in DWI lesions (6). Perfusion can provide parametric maps, including cerebral blood flow (CBF), CBV, and mean transit time (MTT). The total volume of flowing blood in a given volume (100 g) of brain is represented by CBV. The volume of blood flow through a given volume of brain per minute is defined as CBF. The average transit time of blood flow is referred to as MTT. CT perfusion can be used to measure quantitative CBF and CBV due to a linear relationship between contrast concentration and attenuation (8). In addition, CT has the advantage of reducing the overall time for diagnosis because the required time is shorter than that of MR.

The purpose of this report is to describe clinical trials that apply additional hemodynamic information given by CT brain perfusion to assess clinical symptoms and prognosis in a dog with a suspected sellar region tumor.

Case Report

A 10-year-old spayed female Poodle weighing 5.0 kg was referred for blindness. The patient was identified with loss of bilateral pupil light reflex (PLR), visual loss, and right retinal detachment on ophthalmic examination at a local hospital. During a physical examination, the patient had tachycardia with a heart rate of 156 beats per minute and a diastolic blood pressure of 130 mmHg. The respiratory rate could not be accurately assessed due to the patient's panting. There were no significant abnormalities in complete blood count and serum chemistry profiles.

The patient underwent MRI imaging to identify neurological problems related to the optic nerve, optic chiasm, and brain. MRI (1.5-Tesla unit, Vantage Elan™, Canon Medical Systems, Japan) revealed a sessile mass centered on the region of the optic chiasm. The mass was iso- to hypointense on fluid attenuated inversion recovery (FLAIR) and T2-weighted images and mildly hypointense on T1-weighted images compared to gray meter. It had a strong contrast enhancement. Peripheral edema was also identified for the dorsal aspect of the sessile mass that was hyperintense on T2-weighted images and hypointense on T1-weighted images (Fig. 1). There was no specificity on DWI or apparent diffusion coefficient map. The mass was considered to be a tumor originating from the optic chiasm. However, the possibility of optic neuritis and pituitary tumor could not be excluded. 7 days following the MRI scan, a CT simulation for radiation therapy was performed, with CT perfusion conducted to obtain additional hemodynamic information.

CT brain perfusion was performed using a 160-slice CT (Aquilion Lightning 160®, Canon Medical Systems, Otawara, Japan) with the following scanning parameters: tube voltage of 80 kVp, tube current of 100 mAs, 180 images (4 sections, 45 images per 1 section), 10 mm slice thickness, 0.5 s image frequency and 90 s total scan time. A non-ionic iodinated contrast agent, Iodol 370 mg/mL (Pamiray 370; Dongkook Pharm., Seoul, Korea), was administered at a dose of 1 mL per kg of body weight. The contrast agent was injected into an intravenous line at a rate of 1 mL/s and then followed by a 10 mL injection of saline solution at the same injection rate using a dual contrast injector (MEDRAD Salient, Bayer, Australia). The restricted sections included the largest area of the lesion and the level where the rostral cerebral artery was identified for data analysis. Regions of interest (ROIs) for the time-attenuation curve were manually selected within the included section, with the rostral cerebral artery chosen as the input artery, and the dorsal sagittal sinus chosen as the input vein.

The patient was premedicated with glycopyrrolate (0.01 mg/kg, SC, Mobinul inj®, Myungmoon Pharm. Co., Ltd., Korea), butorphanol (0.2 mg/kg, IV, Butophan®, Myungmoon pharm, Korea), and midazolam (0.2 mg/kg, IV, Midazolam inj®, Bukwang, Korea). General anesthesia was induced using a propofol (6 mg/kg, IV, Prepole MCT®, Daewon pharm, Korea) and maintained with isoflurane (Irfan®, Hana Pharm, Korea) in oxygen (2.0 L/min). The patient was positioned in ventral recumbency. Perfusion maps, including CBV, CBF, MTT, and TTP were generated using Vitrea software (Vital Images, Minnetonka, Minnesota) employing a Bayesian algorithm. A lesion distinct from the adjacent gray matter was observed in the left temporal lobe on the CBV map. ROI measuring 0.1 cm^2 was set at this level, along with the contralateral region, to compare perfusion parameter values. CT perfusion showed that the CBV in the left temporal lobe region (13.4 $\pm$ 1.6 mL/100 g) was decreased compared to that in the contralateral region (19.9 $\pm$ 0.3 mL/100 g). There was no specificity on the CBF and the time to peak (TTP) map (Fig. 2).

The patient was discharged without a special event for the recovery of anesthesia. However, after one week, anorexia and decreased consciousness were observed. The patient's condition was continuously monitored. When it was stabilized, radiation therapy was performed at the request of the owner. After that, overall condition of the patient improved during hospitalization. However, its clinical symptoms including seizure, tetraparesis, and loss of consciousness occurred on the 4th day of hospitalization. The patient was administered steroid medication as a treatment for potential acute side effects following radiation therapy. The patient was euthanized at the request of the owner at 40 days after the expression of visual

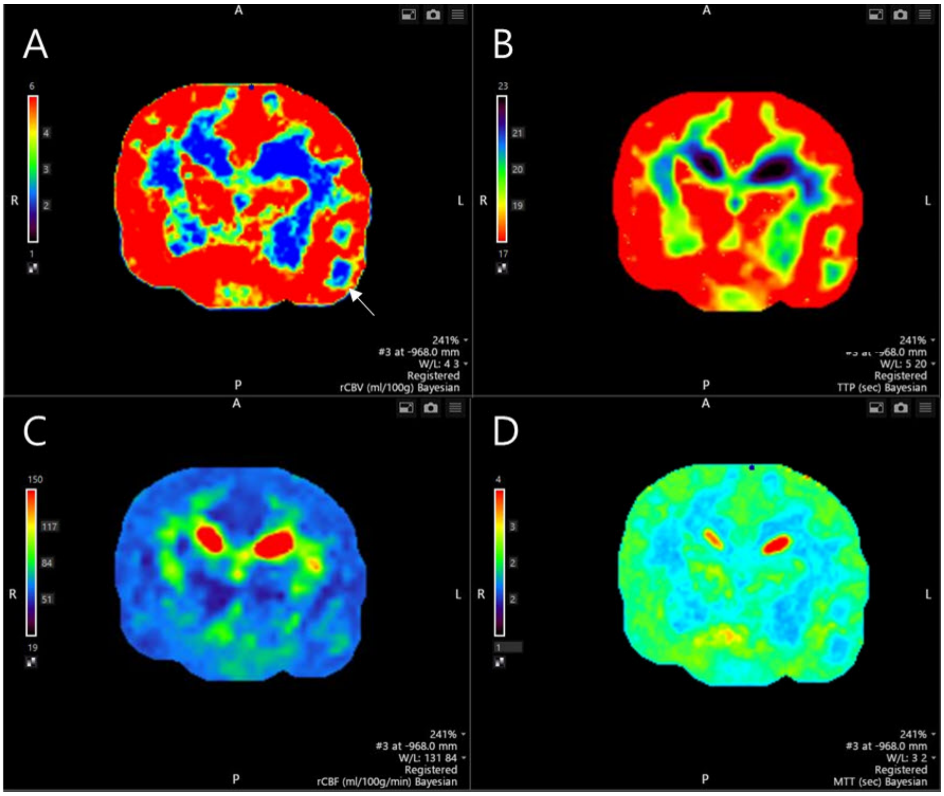

Fig. 2. Relative cerebral blood volume (CBV) (A), cerebral blood flow (B), mean transit time (C), and time to peak (D) brain perfusion images at the level of the temporal lobe. CT perfusion reveals a decrease in CBV in the left temporal lobe region compared to that in the contralateral region (arrow).

loss. Necropsy and biopsy were not performed.

Discussion

Brain MRI showed a sessile mass centered on the region of the optic chiasm. It was distinguished from a pituitary gland on T2-weighted Images and perilesional edema around the dorsal aspect of the mass at the optic chiasm level. The mass was considered as a sellar region tumor, which had a chiasm origin, although the possibility of a pituitary tumor could not be excluded. Mass effect of a sellar region tumor can affect adjacent optic chiasm, circle of Willis, and hypothalamus. The degree and aspect of clinical symptoms can be variable depending on the size and location of the mass (2,4,5,11,12). In this case, no mass effect on the surrounding forebrain was confirmed. However, symptoms of optic nerve tract, such as loss of visual and PLR reflex, and symptoms related to forebrain, such as loss of consciousness and seizure, were found. Therefore, a problem with the perfusion of forebrain supplied by the circle of Willis was suspected. In a previous human case, a suprasellar region pituitary macroadenoma directly compressed the internal carotid artery, leading to decreased vascular supply to cerebral parenchyma. As a result of insufficient vascular flow to this territory, watershed ischemic changes due to hypoperfusion were reported (10).

CT perfusion showed that the left temporal lobe region had a relatively reduced CBV compared to the contralateral region, which was separated from the location of the mass. In humans, rCBV showed greater sensitivity and efficiency in predicting the final infarction compared to other parameters. When only rCBV was considered, it exhibited the highest sensitivity and efficiency, with a similar specificity compared to the combination of other parameters. In the same study, the threshold level of rCBV for discriminating between infarcted and non-infarcted tissue was determined to be 0.6, with an efficiency of 83.1% (6,7). It means that, in an ischemic condition, even when the tissue expands blood vessels and oxygen supply increases through collateral circulation to maintain homeostasis, CBV is reduced when homeostasis cannot be maintained, leading to irreversible tissue damage. Thus, the possibility of progress to infarction was considered for the lesion at the left temporal lobe level with reduced rCBV compared to the contralateral region in the patient. The patient in this case slightly exceeded the threshold suggested in a previous study. However, directly applying human results to dogs is impractical. Thus, there is a need in veterinary medicine for further research on clinically applicable threshold criteria based on a larger number of patients.

Temporal lobe is mainly supplied with arterial blood through the middle cerebral artery (3). It could be suspected that blood vessels are under abnormal pressure due to the mass effect occurring at the level which the middle and the rostral cerebral artery are branched from the internal carotid artery. Changes in brain conditions, such as infarction, can cause temporal lobe epilepsy, where partial seizures are primarily observed. If this progresses to generalized tonic-clonic seizure, it can lead to sudden death (1). In this case, a rapid deterioration of condition was confirmed compared to the prognosis considering the mass size. Forebrain problems such as loss of consciousness and seizure were suspected to be associated with a decrease in CBV in the left temporal lobe.

A limitation of this case was that no additional imaging such as CT angiography was performed after CT perfusion due to sudden deterioration of the patient's condition. Thus, a clear evaluation could not be made for the intracranial artery or collateral circulation. In addition, post-mortem biopsy was not performed. Therefore, an accurate diagnosis of the tumor and infarction at the left temporal lobe level could not be confirmed. Another limitation is that the relationship between DWI and CT perfusion was not confirmed as the patient underwent CT perfusion imaging 7 days after the MRI scan. For clinical use in veterinary medicine, further evaluation of prognosis and differential diagnosis for various brain tumors using CT perfusion is required.

Conclusions

This case report identified a relatively reduced CBV compared to the contralateral region due to a sellar tumor, leading us to consider the possibility of progression to infarction. This finding was considered to be associated with the patient's clinical symptoms and sudden deterioration of condition. This report demonstrates the clinical feasibility of CT perfusion in patients with sellar tumors and suggests that further research involving a larger patient population is warranted.

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Conflicts of Interest

The authors have no conflicting interests.

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