

Canine intraventricular pneumocephalus: a case report

Pneumoencéfalo intraventricular em cão: relato de caso

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ABSTRACT: Pneumocephalus is a well described disease; it is commonly diagnosed in humans, but the condition is rarely encountered in veterinary medicine. Computed tomography (CT) is the gold-standard diagnostic method for identifying this disease, and other methods (such as necropsy) are rarely described. In this report, we describe necropsy findings of a 10-month-old, mixed-breed dog with intraventricular pneumocephalus. The dog was referred to Laboratory of Animal Pathology of the Federal University of Uberlândia, Brazil, for necropsy after being diagnosed with pneumocephalus upon CT. In the examination, the brain had dilation of both lateral ventricles with empty spaces. Histopathology showed congestion and mineralization only near the lateral ventricles, leading to the diagnosis of pneumocephalus based on the macroscopic findings. The animal also showed sinusitis characterized by nasal discharge and neutrophilic infiltration of nasal sinuses. However, bacterial culture was not conclusive because of contamination of the sample. This is therefore an important report that shows necropsy findings of intraventricular pneumocephalus, which is a rare condition in dogs. By documenting the necropsy findings, we hope to help veterinary pathologists, including those with limited access to diagnostic imaging.

KEYWORDS: animal pathology; brain; canine; neuropathology

RESUMO: Pneumoencéfalo é uma condição bem descrita e comumente diagnosticada em humanos, mas raramente encontrada na medicina veterinária. A tomografia computadorizada (TC) é o método diagnóstico padrão-ouro para identificar tal alteração, e outros métodos (como a necropsia) raramente são descritos. Neste relato, são apresentados os achados de necropsia de um cão sem raça definida de 10 meses de idade com pneumoencéfalo intraventricular. O cão foi encaminhado ao Laboratório de Patologia Animal da Universidade Federal de Uberlândia, Brasil, para necropsia após ser diagnosticado com pneumoencéfalo na TC. No exame, o cérebro apresentava dilatação de ambos os ventrículos laterais com espaços vazios; à histopatologia, foram observadas congestão e mineralização próximas aos ventrículos laterais. Com isso foi estabelecido o diagnóstico de pneumoencéfalo, com base nos achados macroscópicos. O animal também apresentou sinusite caracterizada por secreção nasal e infiltração neutrofílica dos seios nasais. No entanto, a cultura bacteriana não foi conclusiva devido à contaminação da amostra. Este é, portanto, um importante relato que mostra achados de necropsia de pneumoencéfalo intraventricular, que é uma condição rara em cães. Ao documentar os achados da necropsia, esperamos ajudar os patologistas veterinários, incluindo aqueles com acesso limitado a técnicas de diagnóstico por imagem.

PALAVRAS-CHAVE: canino; encéfalo; patologia animal; neuropatologia.

INTRODUCTION

Pneumocephalus is a well described and multi-causal pathology commonly reported in human medicine but rare in veterinary medicine. In this disease, the air enters different intracranial (i.e., subdural, epidural, subarachnoid, intraventricular) compartments and it can compress the adjacent nervous tissue, causing neurological signs. The most common cause is trauma, especially after craniectomies, but infection by gas-producing

bacteria has also been reported as a cause of air entry in the brain compartments (DANDY, 1926).

Although it has been well recognized and discussed in human medicine since the beginning of the twentieth century (DANDY, 1926), in veterinary medicine, the first report of pneumocephalus was made in 2004, reinforcing the delay veterinary medicine has when compared to human medicine in some subjects like neuropathology (HICKS et al.,

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2020). However, the causes of pneumocephalus in companion animals are usually the same as in human medicine, in which trauma is the most important cause, followed by a smaller number of reports of nasal cavity infection that have ascended to the brain.

Usually, tomographic diagnosis is satisfactory, so necropsy findings are not described, even though they may aid in a better comprehension of the disease (GAROSI et al., 2002). In addition, it is essential to highlight the importance of necropsy as an alternative diagnostic method in places where access to diagnostic imaging is difficult, which is quite common in routine veterinary medicine. Therefore, in this paper we describe the necropsy findings of an intraventricular pneumocephalus in a 10-month-old mixed-breed dog. With this report, we hope to bring new diagnostic perspectives that can augment the tomographic findings of this pathology.

CASE REPORT

A 10-month-old, male, mixed-breed dog was presented to Laboratory of Animal Pathology of the Federal University of Uberlândia, Brazil, for necropsy examination. Clinical history showed some congenital anomalies, e.g., megaesophagus, arthrogryposis, and prognathism, previously diagnosed by imaging methods. The dog was admitted because of a joint problem and within two days, he presented neurological signs, such as apathy. The signs progressed over the course of one month and the dog started showing unresponsiveness to the environment and convulsions. The complete neurological examination could not be assessed by the authors of this paper because it was not available from the veterinary clinic that examined the animal initially.

During the clinical follow-up, the animal had a computed tomography scan that showed presence of air inside the ventricular compartment on both sides of the brain (Figure 1). The examination showed a discrete to moderate increase in the volume of air (-1106 Hounsfield scale) in the ventricular system leading to a diagnosis of intraventricular pneumocephalus. The examination also showed a bone defect at the ventro-rostral region of the skull, near to the nasal bones. The dog was therefore euthanized due to the poor prognosis and



Figure 1. Computed tomography scan showing both lateral ventricles filled with air (arrows).

welfare considerations. The euthanasia protocol involved the administration of ketamine and xylazine (3 mL:1 mL; intramuscular), plus propofol (30 mL; intravenous), followed by potassium chloride (15 mL; intravenous). This protocol respects animal welfare laws.

The dog was presented for autopsy and during the examination, a thick, brown nasal discharge emerging from both nostrils and the oral cavity was noticed. There was an increase in volume in the cranial region, more distinct around the parietal bone.

In the oral cavity, the animal had a rostral projection of the maxilla bone, characterizing prognathism. All joints in the carpal region had an increased bending stiffness and at the cut surface, there were no gross lesions, suggesting arthrogryposis.

After fixation in a 10% buffered formalin solution, a longitudinal section of the cranium presented empty spaces in the lateral ventricle of both brain hemispheres (Figure 2), more evident in the left ventricle. The left ventricle exhibited a cavity of 7.0 cm × 1.0 cm × 0.5 cm, whereas the right ventricle cavity measured 5.0 cm × 0.5 cm × 0.3 cm. The empty spaces do not present any liquid or other substance. In addition, the adjacent nervous tissue around the midbrain and brainstem was thin and softer than usual because of the compression offered by the air. A sample of the nervous tissue around the frontal and parietal lobe was collected for histopathology.

The nasal sinuses were green to brown, and friable at touching, suggesting necrotic sinusitis. We collected material for bacterial culture; however, the swab collection led to contamination of the sample. A sample of the sinuses was also collected for histopathology.

All microscopic samples were processed according to the routine technique for paraffin embedding and were stained with hematoxylin and eosin. Microscopically, the kidneys, liver, and brain showed congestion. The lungs showed a



Figure 2. Intraventricular pneumocephalus in the brain of a 10-month-old, mixed-breed dog. The longitudinal section of the encephalon shows bilateral empty spaces in both lateral ventricles. Left hemisphere (left) hemisphere was more affected than the right hemisphere (right).

severe, diffuse, mixed pneumonia, hemorrhage, and emphysema. Fragments of brain showed a discrete area of mineralization and discrete area of hemorrhage. Finally, the paranasal sinuses revealed extensive areas of necrosis with neutrophilic and mononuclear inflammatory infiltration, confirming the diagnosis of necrotic sinusitis.

DISCUSSION

From the few reports of canine pneumocephalus, most of the diagnoses are based only on tomographic findings, with little information from necropsy reports (FLETCHER et al., 2006; ROSSMEISL et al., 2015; SENA et al., 2017; KOHLER et al., 2018; SHEA; DOMINGUEZ; STEWART et al., 2018; HICKS et al., 2020). Computed tomography (CT) scans demonstrate low contrast in diverse regions of the brain and are the most accurate diagnostic method to indicate this pathology. However, access to advanced imaging techniques such as magnetic resonance imaging (MRI), CT, and positron emission tomography (PET) are limited in the daily practice of veterinary medicine, especially in undeveloped countries. So, in cases where diagnostic imaging techniques are not an option, the necropsy exam is a feasible tool for pneumocephalus diagnosis.

As reported in the case above, pneumocephalus can cause an increase in the intraventricular pressure and on transverse or longitudinal section, appears only as a cavity of variable size. A common pathology that may resemble this macroscopic presentation is hydrocephalus, which presents an accumulation of cerebrospinal fluid (CSF) in the ventricular compartment. Even though both pathologies can be congenital, there are other etiologies that differentiate them. For example, hydrocephalus can be caused by obstruction in the CSF pathway. Pneumocephalus should appear after traumatic, infectious, or postsurgical events (DEL BIGIO, 1993). In the case reported, we observed a sinusitis together with the pneumocephalus, leading the first suspicion to be pneumocephalus, not hydrocephalus.

In the aforementioned case, the animal had history of both trauma and signs of infection in the nasal cavity, mainly in the nasal sinuses, together with a pneumonia. Although most causes of pneumocephalus in veterinary medicine are traumatic (from accidents or craniotomy), some reports associate necrosis and infection caused by gas-producing bacteria with the presence of air inside the encephalon (DEL BIGIO, 1993; FLETCHER et al., 2006). Isolation and growth of the

bacterial infectious agent is necessary to confirm the diagnosis; however in the case described, we could not perform bacterial culture due the contamination of the sample.

Gross findings (brown discharge and friable consistency of the nasal sinuses) and histopathological findings (neutrophilic infiltration), suggest bacterial infection. This infection is also reinforced by the histopathologic features of the lungs, which had characteristics of pneumonia, with both polymorphonuclear and mononuclear inflammatory cell infiltration. This mixed pneumonia is common in chronic infections that may be due to viral or persistent bacterial infections (LÓPEZ; MARTINSON, 2017). The necrosis of the nasal sinuses and the pneumonia suggest that the respiratory system had been affected for a long time and that the bacterial agent was probably resistant. Therefore, we cannot discard the possibility of the pneumocephalus having been caused by an ascendant bacterial infection localized in the upper respiratory tract.

Intraventricular pneumocephalus can be caused after communication between the ventricular system and the nasal cavity (SENA et al., 2017). In this report, we could not show the exact place where this communication occurred. However, the signs of nasal sinus necrosis seen in the histopathology together with the bone defect found upon CT suggest that the nasal cavity had an important role in the development of the case.

Treatment of pneumocephalus implicates surgical procedures to remove the intracranial air or even conservative methods, in the case of few clinical signs that can improve spontaneously (PEREIRA et al., 2015). However, in veterinary medicine, some surgical procedures involving the intracranial compartment are considered as risk procedures. Depending on the size of the brain commitment, animal welfare can be decreased, leaving euthanasia as the indicated humane endpoint.

CONCLUSIONS

Pneumocephalus can be diagnosed by necroscopic examination, which is helpful in laboratories not equipped with CT or MRI. Besides trauma, sinusitis should be included as one of the possible causes of canine pneumocephalus.

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REFERENCES

- DANDY, W. E. Pneumocephalus (intracranial pneumatocele or aerocele). *Archives of Surgery*, v. 12, n. 5, p. 949-982, 1926.
- DEL BIGIO, M. R. Neuropathological changes caused by hydrocephalus. *Acta Neuropathologica*, v. 85, n. 6, p. 573-585, 1993.

- FLETCHER, D. J. et al. Ventricular pneumocephalus and septic meningoencephalitis secondary to dorsal rhinotomy and nasal polypectomy in a dog. **Journal of the American Veterinary Medical Association**, v. 229, n. 2, p. 240-245, 2006.
- GAROSI, L. S. et al. Intraventricular tension pneumocephalus as a complication of transfrontal craniectomy: a case report. **Veterinary Surgery**, v. 31, n. 3, p. 226-231, 2002.
- HICKS, J. et al. Delayed asymptomatic progressive intraventricular pneumocephalus in a dog following craniotomy. **Journal of Small Animal Practice**, v. 61, n. 5, p. 316-320, 2020.
- KOHLER, R. J. et al. Incidence of and risk factors for major complications or death in dogs undergoing cytoreductive surgery for treatment of suspected primary intracranial masses. **Journal of the American Veterinary Medical Association**, v. 253, n. 12, p. 1594-1603, 2018.
- LÓPEZ, A.; MARTINSON, S. A. Respiratory system, mediastinum, and pleurae. In: ZACHARY, J.F.; MCGAVIN, M.D. (Ed.) **Pathologic Basis of Veterinary Disease**. 6th edition. St Louis: Elsevier, 2017. p. 471-560.
- PEREIRA, C. U. et al. Pneumoencéfalo. **Jornal Brasileiro de Neurocirurgia**, v. 26, n. 1, p. 47-56, 2015.
- ROSSMEISL, J. H. et al. Frame-based stereotactic biopsy of canine brain masses: technique and clinical results in 26 cases. **Frontiers in Veterinary Science**, v. 2, p. 20, 2015.
- SENA, J. O. et al. Intraventricular pneumocephalus associated with nasocephalic necrosis in a puppy: a case report. **Arquivo Brasileiro de Medicina Veterinária e Zootecnia**, v. 69, n. 2, p. 333-339, 2017.
- SHEA, A.; DOMINGUEZ, E.; STEWART, J. Spontaneous non-traumatic tension pneumocephalus in a dog with a nasal meningoencephalocele. **Veterinary Record Case Reports**, v. 6, n. 4, p. e000670, 2018.

