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EC NEUROLOGY
Research Article

COVID 19, Anosmia, Impairment of the Central Nervous System: A Phylogenetic Basis for its Comprehension

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Received: May 27, 2020; **Published:** July 04, 2020

Abstract

Introduction: This paper is divided into two parts; in the first, we show new magnetic resonance imaging (MRI) data obtained from the normal bovine brain in comparison with conventional anatomical studies. In the second part, we formulate a hypothesis about how the COVID-19 can reach the central nervous system (CNS).

Methods: Axial and sagittal MRI sections were obtained from 2 fresh bovine heads. After this, the brains were carefully extracted and fixed in formalin for conventional anatomic sections.

Results: The MRI sections clearly showed anatomical cavitations with probable cerebrospinal fluid inside the olfactory bulbs, with communication with the entire ventricular system.

Conclusion: We think that this paper adds new data about the ventricular system, and we propose that the new 2 cavities identified by MRI could be named Vth and VIth ventricles. As anosmia is a cardinal symptom of the COVID 19 infection, we think that the anatomic olfactory pathway is the pathway through which the virus reaches the CNS.

Keywords: *Bovine; Ventricles; MRI; COVID 19*

Introduction

The use of magnetic resonance imaging (MRI) is new in the government schools of veterinary medicine in our country (Brazil). It is emergent in the world for diagnoses of the bovine brain diseases. Regular studies on the bovine brain by MRI are rare [1,2] but necessary for several accurate diagnoses. In modern textbooks of bovine anatomy, the cavity of the olfactory bulb was not showed [3]. Some authors furnished a brief description of the olfactory recess as an extension of the ventricular system, but detailed MRI findings were not provided [2,3]. Our objective in this study was to compare new MRI data obtained from the bovine brain with conventional anatomical studies. As far as we have known, this is the first detailed description by MRI of the cavitation inside the bovine olfactory bulb. Additionally, we formulate a hypothesis about how COVID-19 can reach the central nervous system (CNS).

Methods

Two standard fresh samples of female adult bovine slaughtered for less than six hours were submitted to MRI studies in a 0.25 ESAOTE Vet-MR Grande equipment. The bovine brain fixed in formalin for a minimal of 30 days were photographed after careful remotion of the olfactory bulbs. After this, they were positioned on a rigid stainless steel table with the base down and cortical convexity upward. Axial

cuts were made every 5 to 6 mm in the craniocaudal direction, with an ordinary homemade knife. The slices obtained were placed in craniocaudal sequence for photographs, aiming future pairing with similar MRI image.

Results

The axial T1 and T2 MRI showed extensive cavities inside the olfactory bulbs with CSF signal (Figure 1). The careful removal of the olfactory bulb showed a 3 mm width orifice on the medial base of the frontal brain, and the anatomical positioning of the clamping and the sagittal T1 and T2 MRI showed continuity between the anterior projection of the long process of the lateral ventricle, extended into the olfactory bulb (Figure 2 and 3). These findings were confirmed in several MRI exams obtained from bovine animals with normal brain. These findings were also confirmed in several MRI exams obtained from canine and equine animals.

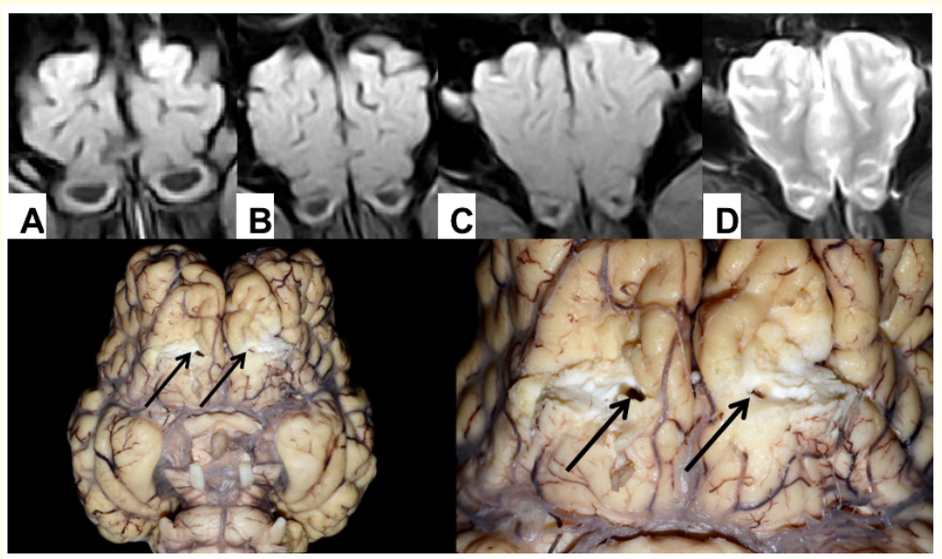

Figure 1: *A and B (T1), normal aspect of the bovine olfactory bulbs. C and D (FLAIR and T2, respectively), approximated site of the anatomical orifices showed on the base of the frontal lobe (arrows), exposed after careful removal of the olfactory bulbs (white region).*

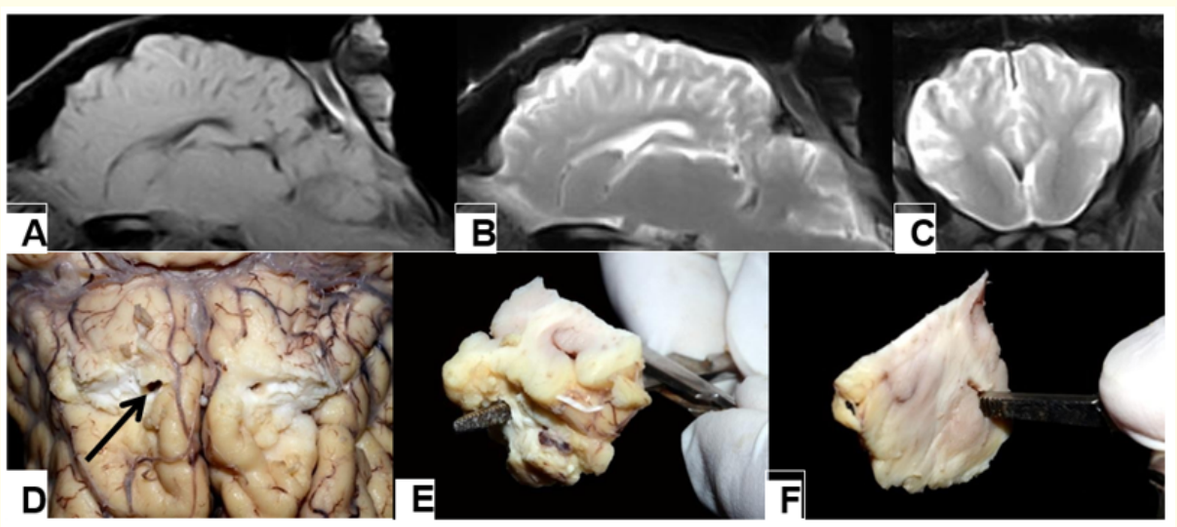

Figure 2: *Sagittal images (A and B, T1 and T2 respectively) showing continuity between the long anterior projection of the of the lateral ventricle and the olfactory bulb, confirmed by the anatomical findings (compare A, B, C with D, E, F).*

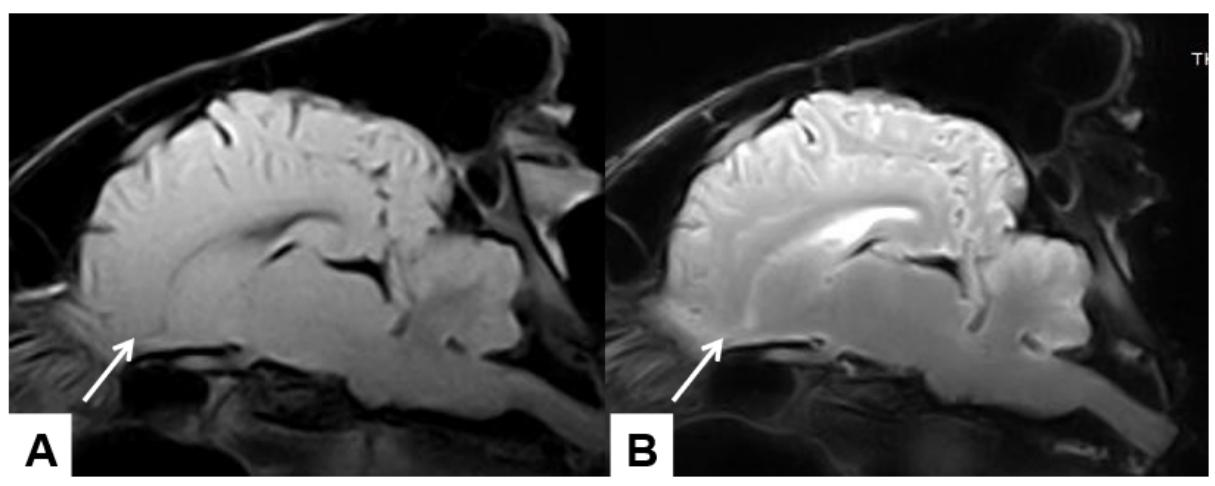

Figure 3: *A and B (T1 and T2, respectively): The anterior projection of the lateral ventricle process presents cranial inflexion and extended into the olfactory bulb (arrows).*

Discussion

The usual terminology of IIIth and IVth ventricle for man and animals presupposes the existence of a first and a second one. The first is the left; the second is the right. The base of this concept return to the time of Gratiolet [4]. Louis Pierre Gratiolet (1815 - 1865) in pioneering neuroanatomical studies conducted in French, was the first to state that in the apes the sulci first develop in the posterior part of the cerebral hemispheres, while in the human fetus the sulci first become visible in the frontal lobes [4]. He deduced that the two sides of the brain-controlled movement of the opposite side of the body and asserted that the left frontal gyri were first developed concerning the right [4]. The classical description of motor aphasia extended this concept by Broca, whose patient had a lesion on the left inferior frontal gyrus [5] and by Hughlings Jackson [6], that wrote... "the left side of the brain is sooner ready for learning. It is the Elder brother". More recent electroencephalographic (EEG) studies showed that in the old age, the EEG alterations comes first from the left-hand side [7]. From this classical and modern concepts and the universal use of the names lateral ventricles, IIIrd and IVth ventricles in neurology and neurosurgery, we cannot propose a modification of this nomenclature. We prefer the names of Vth and VIth ventricles for the above-described cavities showed inside the bovine olfactory bulbs. At this moment we could not demonstrate by histological studies choroid plexus into the olfactory bulbs, then the circulation of the CSF from the lateral ventricles to the olfactory bulbs, or from the olfactory bulbs to the lateral ventricles remains uncertain and the subject of further investigation. For canine and equine animals the olfactory bulbs are also prominent.

Second part - The hypothesis

The olfactory bulbs are prominent and contain CSF in different species, such as dogs, horses and bovines.

There is growing evidence of CNS involvement by COVID-19 and anosmia is a cardinal clinical sign. Delirium [8] and different clinical alterations of the CNS have been described [9]. Cerebrovascular disease is also frequent, but for us, it is multifactorial and secondary to the global inflammatory response, dehydration, hypercoagulable state, and hypoxia [10].

The vast and well developed anatomical pathways between the nasal cavities, olfactory bulbs and temporal lobes of different animals, has involuted in time, decreased in importance until the man, but still exist in the humans.

This allows us to infer that COVID-19 reaches the temporal lobes through this pathway. In the future, we can expect temporal lobe epilepsy, behavioral disturbances, dementia and other clinical signs of temporal lobe impairment as sequelae of the COVID-19 infection.

Conclusion

Based on neuroanatomical studies conducted on animals, and on clinical evidence available for man, we think that COVID 19 reaches the human temporal lobe of the central nervous system through the olfactory pathways. After this, it spreads and multiple neurological complications can arise.

Acknowledgments

The authors thank Dr. Adilson Janjacomo, from the Penápolis city (SP) that supplied the fresh bovine heads for our study.

Conflict of Interest

None.

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Volume 12 Issue 8 August 2020
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