Original Article

A Histopathological Study on the Changes in the Central Nervous System of Dead Cats With Neurological Symptoms

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ABSTRACT

Background: Neurological conditions constitute approximately 10% of feline cases referred to veterinary clinics. Such cases often present manifestations of central nervous system (CNS) damage, including inflammatory lesions, neoplastic growth and structural and cellular transformations.

Objectives: This study aimed at identifying histopathological changes in the CNS of cats that had succumbed to neurological symptoms.

Methods: Microscopic evaluation of different sections within the CNS was conducted on 20 cats that had either died naturally or were euthanized due to neurological signs. After performing a necropsy, we examined the CNS tissues and conducted PCR testing to screen for possible viral infections, including feline infectious peritonitis (FIP), feline immunodeficiency virus (FIV) and feline leukemia virus (FeLV).

Results: The majority of cases showed characteristic histopathologic lesions, notably mononuclear and suppurative meningoencephalitis, perivascular cuffing, disseminated intravascular coagulation (DIC), granulomatous meningoencephalitis, acute neuronal necrosis, liquefactive necrosis, epididymitis, thrombosis and demyelination. Among the 20 cats studied, 12 tested positive for FIP by PCR analysis, while 5 cats exhibited positive results for FIV. Also, FeLV PCR tests displayed positive results in 4 cats. No evidence of feline spongiform encephalopathy (FSE) was observed.

Conclusion: This study is the first of its kind conducted in Iran. Based on the results, the most prevalent viral agents infecting cats' CNS were FIP, FIV and FeLV. The investigation revealed no evidence of FSE in cats with neurological signs.

Keywords: Central nervous system (CNS), Feline, Histopathology, Necropsy, Polymerase chain reaction (PCR)

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Introduction

Various factors affect the nervous system of cats, causing neurological diseases frequently observed in this species. It is worth noting that clinical cases related to neurology make up around 10% of the total caseload in feline medicine referral clinics (Gunn-Moore, 2005). Furthermore, the central nervous system (CNS) in cats is prone to a range of pathogens, including *Escherichia coli*, *Klebsiella* spp., *Pasteurella* spp., *Mycobacteria, Bacteroides* spp. and *Fusobacterium* spp. (Hertzsch & Richter, 2022). *Chlamydia felis* is an essential agent with zoonotic susceptibility, often isolated from cats with chronic conjunctivitis (Barimani et al., 2019).

Additionally, neurological diseases in cats are attributed to various viral agents, which include feline coronavirus (FCoV), feline panleukopenia virus (FPV), feline immunodeficiency virus (FIV), feline leukemia virus (FeLV), rabies virus, Aujeszky disease virus and feline herpesvirus-1 (FHV1). Mycotic infections affecting cats' CNS are rare. Nevertheless, when such infections occur, they can lead to severe illness. Pathologically, fungal diseases in the CNS are characterized by manifestations such as meningoencephalomyelitis, sinonasal lesions, ventriculitis and CNS granuloma (Bentley et al., 2018). Feline infectious peritonitis (FIP) is a viral disease of cats caused by certain strains of a virus called the FCoV, which is different from the human coronavirus. COVID-19 can be transmitted from humans to cats (Mohebali et al., 2022). FIP is a deadly disease that poses a significant threat to domestic and wild felids worldwide. The causative agent is the FCoV with two pathotypes: Feline enteric coronavirus (FECV) and FIP virus (Felten & Hartmann, 2019). The viral genomic mutation that causes changes in cellular tropism can affect the virulence and development of FIP (Kennedy, 2020). FCoV strains are subdivided into two distinct biotypes: FECV and FIP virus (FIPV). Serotype 1 FCoV includes unique feline strains, while serotype 2 appears to have arisen from the recombination between type 1 FCoV and canine coronavirus (Farsijani et al., 2023). FIP is characterized by localized or disseminated fibrinous lesions accompanied by pyogranulomatous and granulomatous inflammation, often leading to proteinaceous effusions in blood vessels. Typical signs of FIP include granulomatous or necrotizing phlebitis and, in some cases, periphlebitis (Malbon et al., 2020). Furthermore, lesions in the CNS are frequently observed, with primary impacts on the leptomeninges, ventricles, choroid plexus, and occasionally the neuroparenchyma (Wang et al., 2018).

A prion is an infectious agent responsible for lethal and neurodegenerative diseases (Kathiriya et al., 2020). Feline spongiform encephalopathy (FSE) is a transmissible spongiform encephalopathy that arises from ingesting feed contaminated with tissue from cattle affected by bovine spongiform encephalopathy (BSE). It is characterized by accumulating an abnormal isoform of the prion protein in the CNS (Iulini et al., 2008). Parasitic diseases that can infect the CNS in cats include toxoplasmosis, *Cuterebra* spp. larvae myiasis, *Toxocara* spp. visceral larva migrans, *Sarcocystis* spp. and *Dirofilaria immitis* (Gunn-Moore, 2005). *Toxoplasma gondii* infects all species of warm-blooded animals, including humans, domestic cats, and other Felidae, which are its definitive hosts (Mosallanejad et al., 2017).

Additionally, persisting pain may lead to chronic diseases and cause changes in the CNS (Nikjooy et al., 2022). This study represents the initial investigation in Iran, where histopathological examination was conducted on CNS lesions displaying neurological symptoms. Moreover, an assessment of the CNS tissue was performed to detect the presence of FSE.

Materials and Methods

This study was designed to explore feline neurological cases involving necropsy investigations of cats that had succumbed to several neurological disorders. A standard postmortem protocol encompassed gross examination, histopathological analysis and PCR tests for viral infections like FIV, FeLV and FIP. A total of 20 cats displaying neurological signs or euthanized due to unresponsiveness to treatment or poor prognosis were subjected to necropsy after recording their medical history and clinical manifestations. The cases were referred from private sector veterinary centers in Tehran City and Tehran University Veterinary Hospital (Figure 1). They were necropsied in the Pathology Department of the Faculty of Veterinary Medicine of Tehran University. During the necropsy process, the brain and spinal cord of each animal were completely removed immediately after death (Figure 2).

Histopathological investigations

Histopathological sampling was performed from various anatomical regions of the CNS, including the cerebral cortex, cortical and basal parts of the cerebellum, hippocampus, thalamus, posterior and anterior sections of the medulla oblongata, as well as different segments of the spinal cord, such as cervical, thoracic, lumbar and sacral regions (Iulini et al., 2008). Tissues were placed

Figure 1. Anisocoria and uveitis observed in a cat affected by FIP

in a 10% neutral buffered formalin solution to maintain structural integrity. After the tissue process, hematoxylin and eosin (H&E) staining were applied to the prepared slides. The sections were then mounted onto glass slides, ready for detailed histopathological analysis (Slaoui & Fiette, 2011).

Special staining

In specific cases where the destruction of the myelin structure was detected, a targeted luxol fast blue staining technique was applied to the tissues (Meknatkhah et al., 2019). Immunohistochemical staining with the CD163 marker was used on histopathological sections because its immunoreactivity can be observed in resident macrophages, and using CD68 marker to detect inflammatory macrophages (Lau et al., 2004). This staining aimed to distinguish and differentiate inflammatory and tissue macrophage cells from other cell types (Hirabayashi et al., 2020).

Molecular diagnostic PCR testing

Tissue samples from a small piece of the different areas of the brain and spinal cord mentioned in the pathology sampling were collected using a sterile

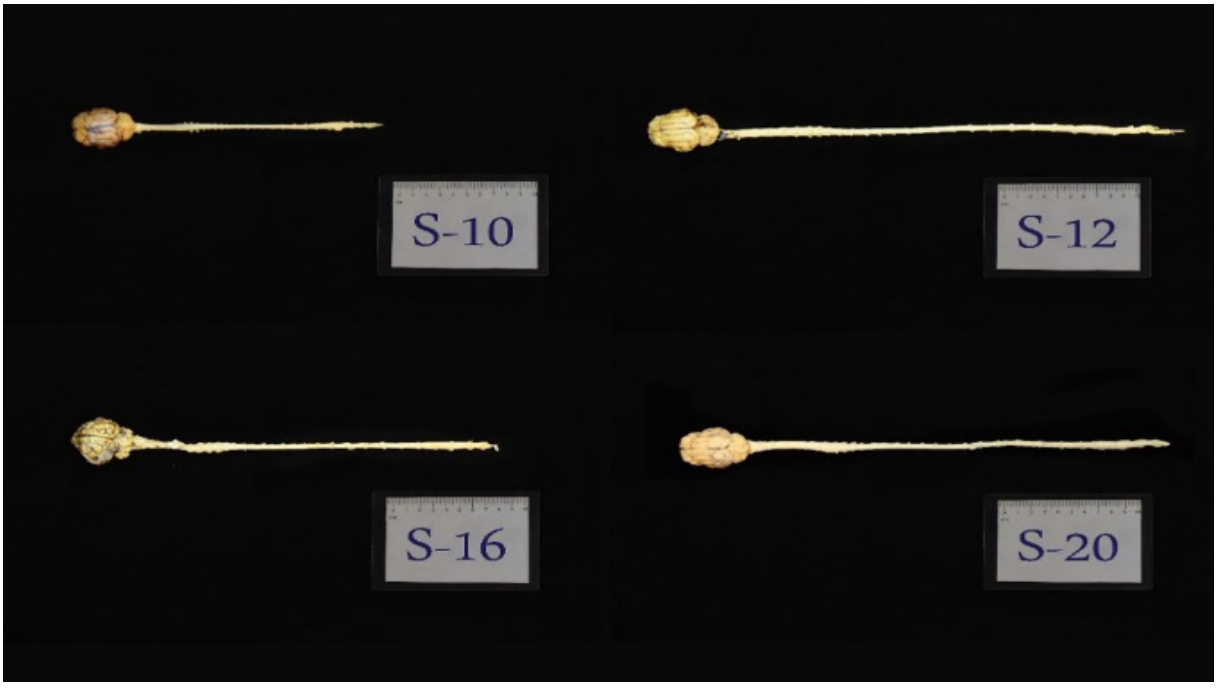

Figure 2. Some specimens of the brain and spinal cord extracted from cats following the fixation process

scalpel blade and, after labeling, were stored at a temperature of -20 ˚C. SinaClon kit was used for RNA extraction. In this step, sterile and nuclease-free microtubes were utilized for the Sina Clon cDNA synthesis kit (Cat. No: RT5201). Synthesized cDNA was used to perform the RT PCR process to detect FIV, FeLV and FIP viruses (Najafi et al., 2014).

Statistical analysis

The statistical analyses were performed using SPSS software, version 26.0. Descriptive statistics were presented as Mean±SEM and median. To determine statistical significance, the chi-square and Fisher exact tests were employed. $P<0.05$ were considered statistically significant.

Results

This study investigated 20 cats that died due to neurological symptoms. The mean age was 2 years, with 18 being mixed breed and 2 of Scottish breed. Gender distribution included 7 intact females, 1 spayed female, 10 intact males and 2 castrated males. Common neurological symptoms were ataxia, incoordination, head tilt, proprioceptive deficits, and tremors. Histopathologic lesions were detected in all CNS samples. The lesions were associated with various neurologic diseases. In descending order of frequency, they were categorized as follows: Meningitis (Figures 3a, and 3b), meningoencephalitis (Figures 3c and 3d), granulomatous inflammation (Figures 3b and 3d), nonsuppurative encephalitis (Figures 3 and 4), suppurative encephalitis (Figure 5b) and hemorrhage (Figure 3a). Notably, no histopathologic lesions of FSE were detected in any of these cats. Other notable histopathological findings included perivascular cuffing (PVC) (Figures 4a, 4b, 5a and 5b), disseminated intravascular coagulation (DIC) (Figure 5c), edema, thrombosis (Figure 5c), demyelination (Figure 5d), acute neuronal death (Figure 5d), gliosis, and the presence of bacterial colonies (Figure 5c). Based on the PCR results performed on brain tissue samples, the findings revealed that 12 cats tested positive for FIP, while 5 cats were infected with FIV, and 4 cats were diagnosed with FeLV disease (Figure 6). The PCR result of FIP disease was positive in all the cases that had granulomatous inflammation in the CNS but Fisher exact test showed no statistically significant difference between the presence of general injuries of the nervous system such as PVC, encephalitis, DIC, perivascular edema, acute neuronal necrosis, liquefactive necrosis, ependymitis, thrombosis, demyelination, CD163, satellitosis and gliosis with FIP, FIV and FeLV positivity ($P>0.05$).

Discussion

The manifestations of nervous signs in cats can be similar across different diseases that affect the nervous system. This similarity in clinical presentation poses a challenge in diagnosing specific neurological conditions only based on clinical signs. Therefore, histopathological investigation of the CNS, as focused in this study, becomes critical in recognizing the underlying pathology and causative factors, such as viral diseases like FIV, FeLV and FIP. This evaluation aids in distinguishing between different neurological disorders and develops our understanding of their typical features, finally leading to better management and treatment approaches for affected feline patients (Camps et al., 2019). Diseases that affect the CNS in cats include inflammation, degeneration, congenital and FSE (Bradshaw et al., 2004). Various pathogens, including bacterial agents, viruses, fungi, parasites, and prions, can cause CNS infection. Infection in the CNS is mainly seen in meningitis, encephalitis, and abscess (Giovane & Lavender, 2018). In this current study, molecular evaluation was performed to screen viral diseases besides the histopathological analysis of brain and spinal cord tissues. Among the detected neurologic lesions, the most prevalent were characterized as inflammatory lesions, including meningitis, encephalitis, and meningoencephalitis. These inflammatory lesions displayed mononuclear inflammation, a typical characteristic often associated with viral infections. This inclusive methodology combining histopathological and molecular assessments offers valuable data for understanding the underlying viral etiologies and their impact on the CNS in affected cats (Barrantes Murillo et al., 2022). Further important histopathological findings in CNS tissues included the presence of granulomatous meningoencephalitis, detected at varying intensities. Alongside these, common histopathological lesions, such as PVC, encephalitis, DIC, perivascular edema, acute neuronal necrosis, liquefactive necrosis, ependymitis, thrombosis, demyelination, satellitosis, and gliosis, were apparent in nearly all cases. Notably, four cats exhibited manifestations of granulomatous inflammation, with positive PCR results for FIP. In certain cases, where infiltration of macrophages was confirmed through immunohistochemical staining with the CD68 marker, the PCR results also yielded positive results for FIP disease. The study further confirms FIP as the predominant cause of granulomatous inflammation in cats (Gonçalves, 2020). Even though granulomatous lesions were not present in all cats with positive PCR tests for FIP, it is important to know that studies have confirmed the potential for false positives in PCR testing. To reach

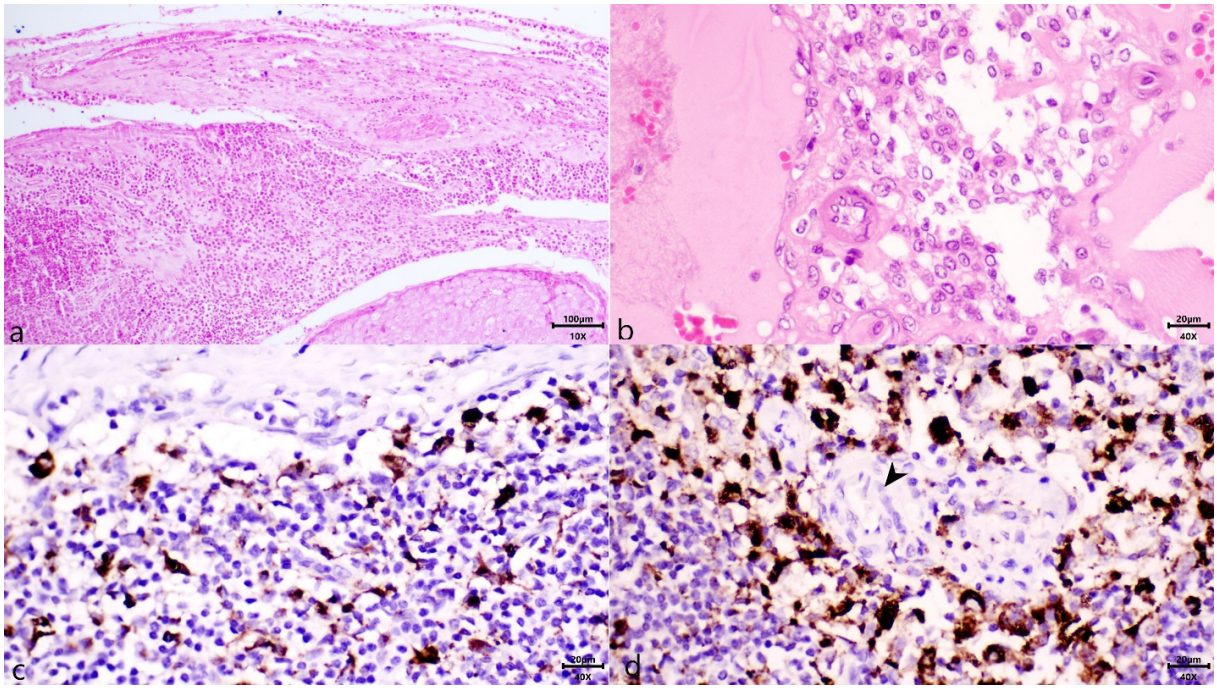

Figure 3. Mononuclear meningoencephalitis of cervical spinal cord

a) FIP-positive cat, b) Histiocytic cerebral cortex meningitis; c and d) Mononuclear meningitis in which macrophage cells marked by immunohistochemical staining with CD68 marker, d) Mononuclear perivascular cuffing around a blood vessel (arrowhead)

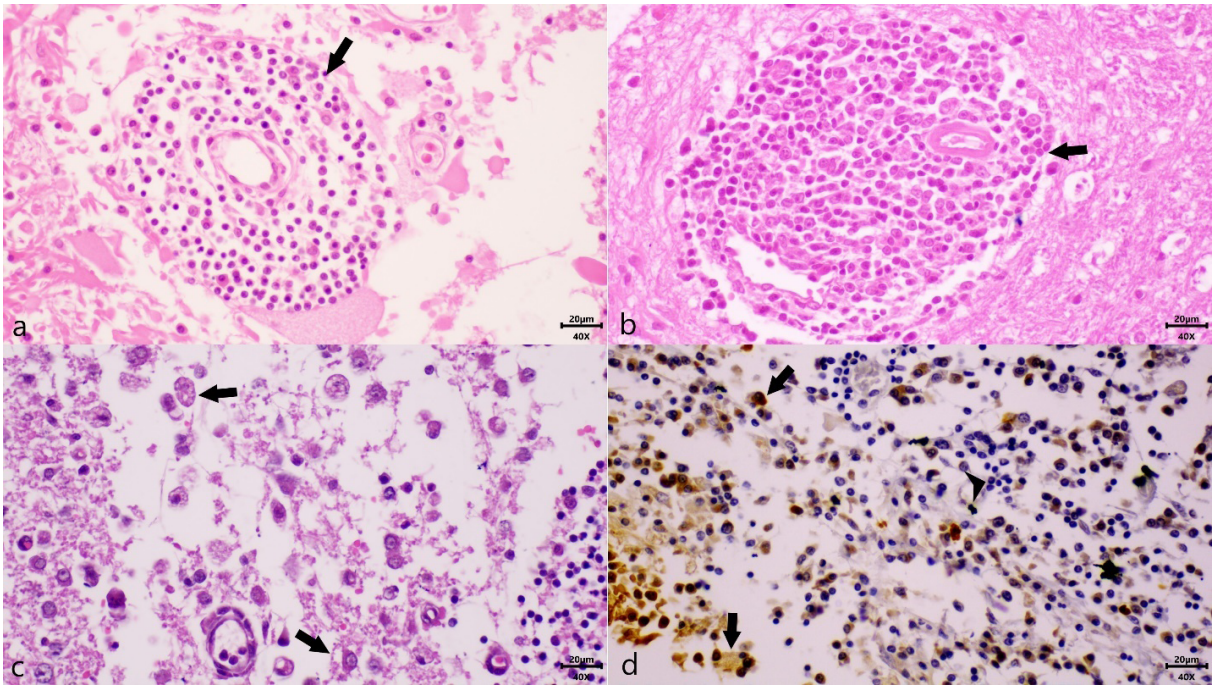

Figure 4. Nonsuppurative encephalitis

a and b) Remarkable perivascular cuffing of cerebral cortex, c) Cerebellar hemorrhage and edema with infiltration of phagocytic gitter cells (arrows), d) Cerebral histiolymphocytic infiltrate cells include a mixture of macrophages, identified by immunohistochemical staining with the CD163 marker (arrows), accompanied by lymphocytes (arrowhead)

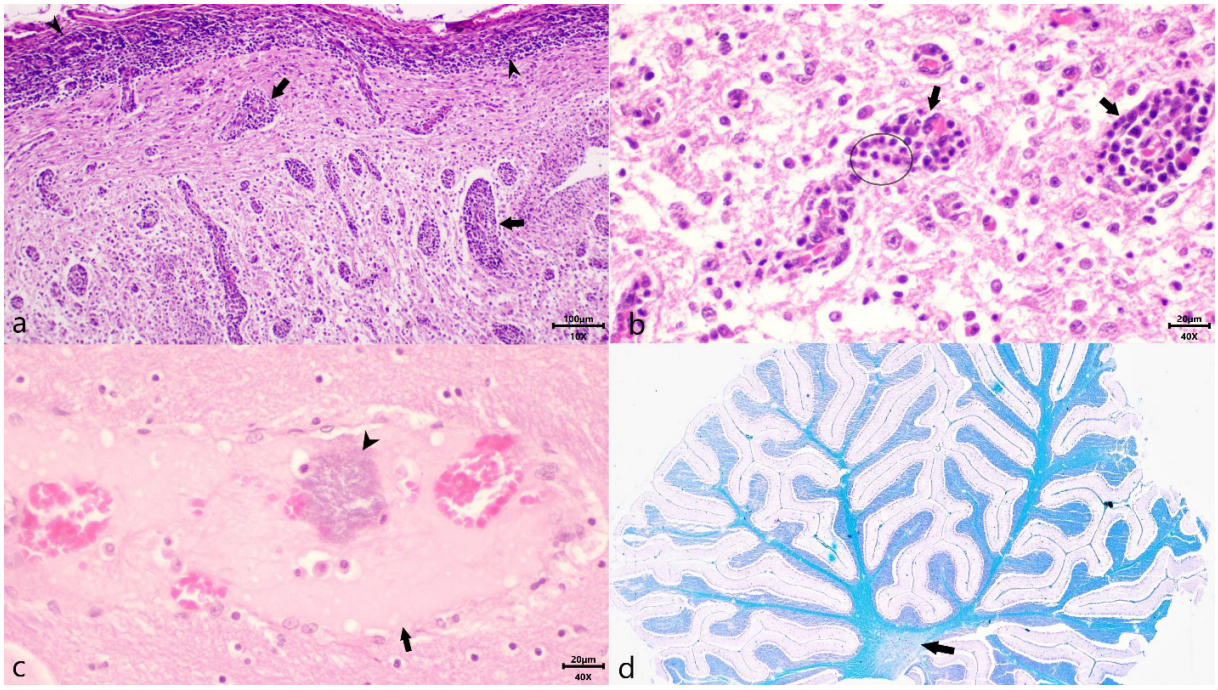

Figure 5. Meningomyelitis with numerous PVC

a) Sacral spinal cord, b) Cells mostly consisting of lymphocytes and neutrophils (circle), c) DIC with the presence of bacterial colony (arrowhead) in medulla oblongata; d) Demyelination in the basal area of the cerebellum (arrow), luxol fast blue staining

a definitive diagnosis of pathological lesions associated with FIP disease, additional measures like Immunohistochemistry for FCoV are recommended (Barker & Tasker, 2020). FIV can attack the CNS by crossing the blood-brain barrier after primary infection. This invasion occurs through infected leukocytes. Once inside the CNS, FIV exhibits productive cell tropism for microglia and perivascular macrophages (Power, 2018). Nonsuppurative meningoencephalitis is a prominent characteristic detected in viral infections like FIV and FeLV. Infiltrations of lymphocytes were evident in various regions of the CNS, including the leptomeninges, neuropil and particularly in the Virchow-Robin space (Schwab et al., 2007). Microscopic examination of the CNS in cats affected by viral diseases, such as FIV, reveals notable pathological changes. These changes include perivascular mononuclear cell infiltrations observed within the meninges of the brain, the choroid plexus and the dura of the spinal cord (Ryan et al., 2005). In the present study, the most observed lesions in the CNS of cats whose PCR tests for FIV and or FeLV were positive, mononuclear meningitis, PVC of inflammatory cells, mainly lymphocytes, and plasma cells that is a hallmark of a viral or immune-mediated inflammatory process were the major histopathological findings (Matiasek et al., 2023). Besides the mentioned microscopic lesions, the rate of other detected microscopic findings based on their prevalence included encephalitis, hyperemia, meningeal edema, perivascular edema, acute neuronal necrosis, liquefactive necrosis, and ependymitis, respectively. Another

Table 1. Characteristics of primers used to detect viral diseases

Gene	PCR	Fragment Size (bp)	Primer, Sequence	Reference
FIV	RT-PCR	374	Forward (5'-3'): GAAGAAGGAAATGCAGGTAAGTT-TAGAA Reverse (3'-5'): TAATCCT GCTACTGGGTTATAC-CAATT	Zhang et al., 2017
FeLV	RT-PCR	450	Forward (5'-3'): ACTAACCAATCCCCACGC Reverse (3'-5'): ACTAACCAATCCCCACGC	Victor et al., 2020
FIP	RT-PCR	223	Forward (5'-3'): GGCAACCCGATGTTTAAAACTGG Reverse (3'-5'): CACTAGATCCAGACGTTAGCTC	Mohammed Ibrahim et al., 2022

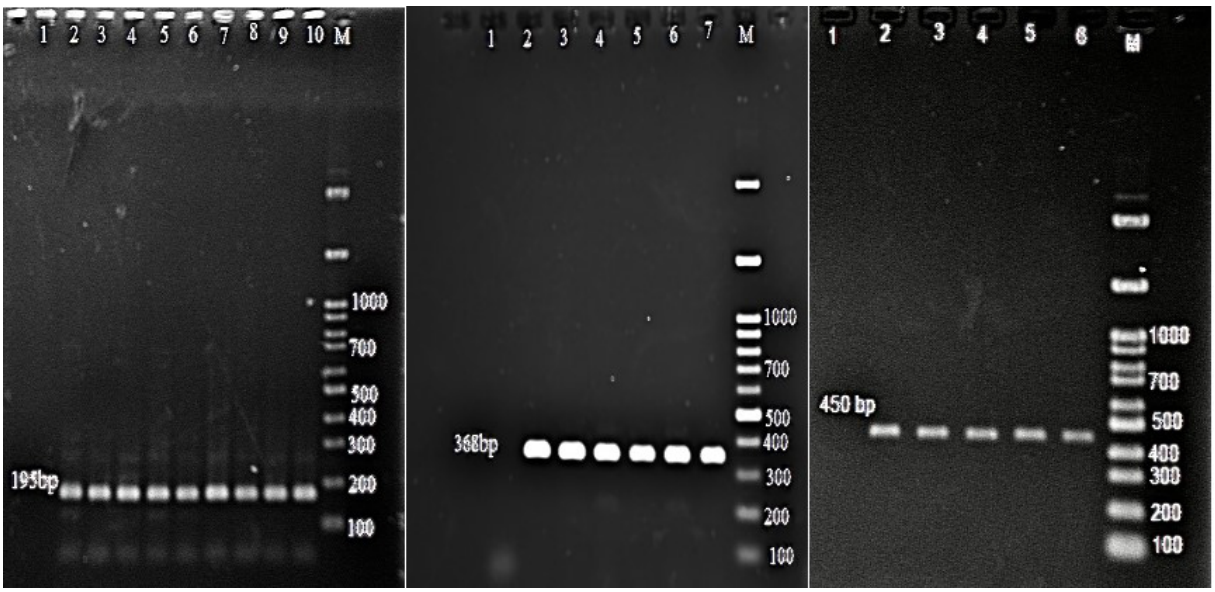

Figure 6. The electrophoresis results of some PCR products obtained from cats infected (a: FIP, b: FIV, c: FeLV)

notable neurological lesion detected was the destruction of the myelin structure. This lesion is encountered in various neurological diseases. Degeneration of the axon's myelin, along with the loss of neurons and glial cells, ischemia, and inflammation, contributes to the formation of glial scars and cystic cavities in the spinal cord (Khodabakhshi Rad et al., 2023). Notably, FSE was a significant disease monitored in this study, and its examination in Iran was conducted for the first time. FSE has been reported in several countries worldwide in recent years, including Germany, Norway, Great Britain and France (Bratberg et al., 1995; Lezmi et al., 2003; Hilbe et al., 2009; Eiden et al., 2010). FSE is classified as a subtype of transmissible encephalopathy, and it is caused by prions. Because of the similarities between FSE and BSE, there are concerns about the possible occurrence of BSE in Felidae (Arnold et al., 2017). Because of the similarity of neurological symptoms between FSE and many other neurological disorders in cats, the diagnosis of FSE can be reached through histopathological evaluations, immunohistochemistry, western blot, or ELISA performing on brain. Furthermore, confirming the causative prion responsible for FSE demands the use of molecular diagnostic methods. By combining these approaches, a decisive diagnosis of FSE can be established, allowing accurate differentiation from other neurological conditions (Fraser et al., 1992). FSE leads to vacuolation and spongiosis throughout the nervous system, particularly affecting regions such as the medulla oblongata, basal ganglia, and geniculate nucleus (Iulini et al., 2008). In this study, which represents the first research on FSE disease monitoring in Iran, no suspected cases of this disease were observed based on the histopathological changes in the nervous system.

Conclusion

In this study, all cats that exhibited neurological symptoms were found to have microscopic lesions in their CNS tissues. In this order, the prevailing viral agents in these cases were FIP, FIV and FeLV. Notably, no evidence of FSE was detected in any of these cats. These findings shed light on the distinct viral causes behind neurological issues in felines, emphasizing the importance of accurate identification for effective diagnosis and management.

Ethical Considerations

Compliance with ethical guidelines

All ethical principles are considered in this article. All animals were examined postmortem and either died of disease or were euthanized due to non-response to treatment with the consent of their owners.

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Authors' contributions

All authors equally contributed to preparing this article.

Conflict of interest

The authors declared no conflict of interest.

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References

Arnold, M. E., Simons, R. R. L., Hope, J., Gibbens, N., & Adkin, A. L. (2017). Is there a decline in bovine spongiform encephalopathy cases born after reinforced feed bans? A modelling study in EU member states. *Epidemiology & Infection, 145*(11), 2280-2286. [DOI:10.1017/S0950268817001236] [PMID]

Barker, E., & Tasker, S. (2020)."Update on feline infectious peritonitis." *In Practice, 42*(7), 372-383. [DOI:10.1136/inp.m3187]

Barimani, M., Mosallanejad, B., Ghorbanpoor, M., & Esmaeilzadeh, S. (2019). Molecular detection of Chlamydia felis in cats in Ahvaz, Iran. *Archives of Razi Institute, 74*(2), 119–126. [PMID]

Barrantes Murillo, D. F., Negrão Watanabe, T. T., & Del Piero, F. (2022). Pathology in practice. *Journal of the American Veterinary Medical Association, 259*(S2), 1-4. [DOI:10.2460/javma.21.04.0201] [PMID]

Bentley, R. T., Taylor, A. R., & Thomovsky, S. A. (2018). Fungal infections of the central nervous system in small animals: Clinical features, diagnosis, and management. *The Veterinary Clinics of North America. Small Animal Practice, 48*(1), 63–83. [DOI:10.1016/j.cvsm.2017.08.010] [PMID]

Bradshaw, J. M., Pearson, G. R., & Gruffydd-Jones, T. J. (2004). A retrospective study of 286 cases of neurological disorders of the cat. *Journal of Comparative Pathology, 131*(2-3), 112-120. [DOI:10.1016/j.jcpa.2004.01.010] [PMID] [PMCID]

Bratberg, B., Ueland, K., & Wells, G. A. H. (1995). Feline spongiform encephalopathy in a cat in Norway. Veterinary Record, 136(17). [DOI: 10.1136/vr.136.17.444] [PMID]

Camps, T., Amat, M., & Manteca, X. (2019). A review of medical conditions and behavioral problems in dogs and cats. *Animals, 9*(12), 1133. [DOI:10.3390/ani9121133] [PMID] [PMCID]

Eiden, M., Hoffmann, C., Balkema-Buschmann, A., Müller, M., Baumgartner, K., & Groschup, M. H. (2010). Biochemical and immunohistochemical characterization of feline spongiform encephalopathy in a German captive cheetah.*The Journal of General Virology, 91*(Pt 11), 2874–2883. [DOI:10.1099/vir.0.022103-0] [PMID]

Farsijani, F., Safi, S., & Shirazi Beheshtiha, S. H. (2023). Comparison of the performance of bioresonance, electrophoresis and RT-PCR in the diagnosis of feline infectious peritonitis. *Archives of Razi Institute, 78*(3), 1077-1085. [PMID]

Felten, S., & Hartmann, K. (2019). Diagnosis of feline infectious peritonitis: A review of the current literature. *Viruses, 11*(11), 1068. [DOI:10.3390/v11111068] [PMID] [PMCID]

Fraser, H., Bruce, M. E., Chree, A., McConnell, I., & Wells, G. A. H. (1992). Transmission of bovine spongiform encephalopathy and scrapie to mice. *Journal of General Virology, 73*(8), 1891-1897. [DOI:10.1099/0022-1317-73-8-1891] [PMID]

Giovane, R. A., & Lavender, P. D. (2018). Central nervous system infections. *Primary Care, 45*(3), 505–518. [DOI:10.1016/j.pop.2018.05.007] [PMID]

Gonçalves, R. (2020). New considerations about inflammatory brain diseases in cats and dogs. *In Practice, 42*(10), 547-553. [DOI:10.1136/inp.m4355]

Gunn-Moore D. (2005). Infectious diseases of the central nervous system. *The Veterinary Clinics of North America. Small Animal Practice, 35*(1), 103–vi. [DOI:10.1016/j.cvsm.2004.09.003] [PMID] [PMCID]

Hertzsch, R., & Richter, A. (2022). Systematic review of the pharmacological evidence for the selection of antimicrobials in bacterial infections of the central nervous system in dogs and cats. *Frontiers in Veterinary Science, 8,* 769588. [DOI:10.3389/fvets.2021.769588] [PMID] [PMCID]

Hilbe, M. M., Soldati, G. G., Zlinszky, K. K., Wunderlin, S. S., & Ehrensperger, F. F. (2009). Immunohistochemical study of PrPScdistribution in neural and extraneural tissues of two cats with feline spongiform encephalopathy. *BMC Veterinary Research, 5,* 11. [DOI:10.1186/1746-6148-5-11] [PMID] [PMCID]

Hirabayashi, M., Chambers, J. K., Sumi, A., Harada, K., Haritani, M., & Omachi, T., et al. (2020). Immunophenotyping of nonneoplastic and neoplastic histiocytes in cats and characterization of a novel cell line derived from feline progressive histiocytosis. *Veterinary Pathology, 57*(6), 758-773. [DOI:10.1177/0300985820953538] [PMID]

Iulini, B., Cantile, C., Mandara, M. T., Maurella, C., Loria, G. R., & Castagnaro, M., et al. (2008). Neuropathology of Italian cats in feline spongiform encephalopathy surveillance. *Veterinary Pathology, 45*(5), 626-633. [DOI:10.1354/vp.45-5-626] [PMID]

Kathiriya, J. B., Shah, N. M., Sindhi, S. H., Trangadia, B. J., Tajapara, M. M., Vagh, A. A., & Bhedi, K. R. (2020). Transmissible spongiform encephalopathies: Emerging threats. *International Journal of Veterinary Sciences and Animal Husbandry 5*(6): 64-71 [Link]

Kennedy, M. A. (2020). Feline infectious peritonitis: Update on pathogenesis, diagnostics, and treatment. *The Veterinary Clinics of North America. Small Animal Practice, 50*(5), 1001–1011. [DOI:10.1016/j.cvsm.2020.05.002] [PMID]

Khodabakhshi Rad, A., Kazemi Mehrjerdi, H., Pedram, M. S., Azizzadeh, M., & Amanollahi, S. (2023). Clinical evaluation of the effect of methylprednisolone sodium succinate and meloxicam in experimental acute spinal cord injury. *Iranian Journal of Veterinary Medicine, 17*(2), 129-138. [DOI:10.32598/IJVM.17.2.1005246]

Lau, S. K., Chu, P. G., & Weiss, L. M. (2004). CD163: A specific marker of macrophages in paraffin-embedded tissue samples. *American Journal of Clinical Pathology, 122*(5), 794-801. [DOI:10.1309/QHD6YFN81KQXUUH6] [PMID]

Lezmi, S., Bencsik, A., Monks, E., Petit, T., & Baron, T. (2003). First case of feline spongiform encephalopathy in a captive cheetah born in France: PrP sc analysis in various tissues revealed unexpected targeting of kidney and adrenal gland. *Histochemistry and Cell Biology, 119,* 415-422. [DOI:10.1007/s00418-003-0524-5] [PMID]

Malbon, A. J., Michalopoulou, E., Meli, M. L., Barker, E. N., Tasker, S., & Baptiste, K., et al. (2020). Colony stimulating factors in early feline infectious peritonitis virus infection of monocytes and in end stage feline infectious peritonitis; a combined in vivo and in vitro approach. *Pathogens, 9*(11), 893. [DOI:10.3390/pathogens9110893] [PMID] [PMCID]

Matiasek, K., Pfaff, F., Weissenböck, H., Wylezich, C., Kolodziejek, J., & Tengstrand, S., et al. (2023). Mystery of fatal 'staggering disease'unravelled: Novel rustrela virus causes severe meningoencephalomyelitis in domestic cats. *Nature Communications, 14*(1), 624. [DOI:10.1038/s41467-023-36204-w] [PMID] [PMCID]

Meknatkhah, S., Sharif Dashti, P., Mousavi, M. S., Zeynali, A., Ahmadian, S., & Karima, S., et al. (2019). Psychological stress effects on myelin degradation in the cuprizone-induced model of demyelination. *Neuropathology, 39*(1), 14-21. [DOI:10.1111/neup.12522] [PMID]

Mohammed Ibrahim, O., Bara Allawe, A., & Ali Kadhim, H. (2022). Isolation and molecular detection of feline infectious peritonitis virus. *Archives of Razi Institute, 77*(5), 1709-1714. [PMID]

Mohebali, M., Hassanpour, G., Zainali, M., Gouya, M. M., Khayatzadeh, S., & Parsaei, M., et al. (2022). SARS-CoV-2 in domestic cats (Felis catus) in the northwest of Iran: Evidence for SARS-CoV-2 circulating between human and cats. *Virus Research, 310,* 198673. [DOI:10.1016/j.virusres.2022.198673] [PMID]

Mosallanejad, B., Hamidinejat, H., Seifiabad Shapouri, M. R., & Rezaei Ghaleh, F. (2017). A comparison between serological and molecular tests in diagnosis of Toxoplasma gondii infection among stray cats in Ahvaz, southwestern Iran. *Archives of Razi Institute, 72*(2), 107-114. [DOI:10.22092/ARI.2017.109841]

Najafi, H., Madadgar, O., Jamshidi, S., Ghalyanchi Langeroudi, A., & Darzi Lemraski, M. (2014). Molecular and clinical study on prevalence of feline herpesvirus type 1 and calicivirus in correlation with feline leukemia and immunodeficiency viruses. *Veterinary Research Forum: An International Quarterly Journal, 5*(4), 255–261. [PMID]

Nikjooy, N., Asghari, A., Hassanpour, S., & Arfaee, F. (2022). Study of anti-nociceptive role of the manna of hedysarum and the neurotransmitter systems involved in mice. *Iranian Journal of Veterinary Medicine, 16*(3), 265-273. [Link]

Momtaz, H., Isfahani, M. S., Adibi, S., Momeni, M., & Souod, N. (2012). Molecular diagnosis of Feline Immunodefi-ciency Virus (FIV) in cerebrospinal fluid (CSF) and blood by RT-PCR and PCR methods among stray cats and relationships with cli-nical signs. *Revue de Medecine Veterinaire, 163*(1), 25-30. [Link]

Power, C. (2018). Neurologic disease in feline immunodeficiency virus infection: disease mechanisms and therapeutic interventions for NeuroAIDS. *Journal of Neurovirology, 24*(2), 220-228. [DOI: 10.1007/s13365-017-0593-1] [PMID]

Ryan, G., Grimes, T., Brankin, B., Mabruk, M. J., Hosie, M. J., Jarrett, O., & Callanan, J. J. (2005). Neuropathology associated with feline immunodeficiency virus infection highlights prominent lymphocyte trafficking through both the blood-brain and blood-choroid plexus barriers. *Journal of neurovirology, 11,* 337-345. [DOI: 10.1080/13550280500186445] [PMID]

Schwab, S., Herden, C., Seeliger, F., Papaioannou, N., Psalla, D., & Polizopulou, Z., et al. (2007). Nonsuppurative meningoencephalitis of unknown origin in cats and dogs: An immunohistochemical study. *Journal of Comparative Pathology, 136*(2-3), 96-110. [DOI:10.1016/j.jcpa.2006.11.006] [PMID] [PMCID]

Slaoui, M., & Fiette, L. (2011). Histopathology procedures: From tissue sampling to histopathological evaluation. *Methods in Molecular Biology (Clifton, N.J.), 691,* 69–82. [DOI:10.1007/978-1-60761-849-2_4] [PMID]

Victor, R. M., Bicalho, J. M., Andrade, M. B., Bueno, B. L., de Abreu, L. R. A., & Bicalho, A. P. D. C. V., et al. (2020). Molecular detection of feline leukemia virus in oral, conjunctival, and rectal mucosae provides results comparable to detection in blood. *Journal of Clinical Microbiology, 58*(2), e01233-19. [DOI:10.1128/JCM.01233-19] [PMID] [PMCID]

Wang, H., Hirabayashi, M., Chambers, J. K., Uchida, K., & Nakayama, H. (2018). Immunohistochemical studies on meningoencephalitis in feline infectious peritonitis (FIP). *The Journal of Veterinary Medical Science, 80*(12), 1813–1817. [DOI:10.1292/jvms.18-0406] [PMID] [PMCID]

Zhang, J., Wang, L., Li, J., Kelly, P., Price, S., & Wang, C. (2017). First molecular characterization of feline immunodeficiency virus in domestic cats from mainland China. *Plos One, 12*(1), e0169739. [DOI:10.1371/journal.pone.0169739] [PMID] [PMCID]

مطالعه پژوهشی

مطالعه هیستوپاتولوژیک دستگاه عصبی مرکزی در گربه‌های تلف‌شده متعاقب بروز علائم عصبی

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چکیده

زمینه مطالعه: بیماری‌های عصبی تقریباً ۱۰ درصد از کل موارد گربه‌سانان مراجعه‌کننده به کلینیک‌های دامپزشکی را تشکیل می‌دهند. چنین مواردی اغلب تظاهرات مختلفی از آسیب سیستم عصبی مرکزی (CNS) از جمله ضایعات التهابی، رشد نئوپلاستیک، دگرگونی‌های ساختاری و سلولی را نشان می‌دهند.

هدف: شناسایی تغییرات هیستوپاتولوژیک در CNS گربه‌هایی که در اثر علائم عصبی تلف شده بودند، هدف اصلی این مطالعه بود.

روش کار: ارزیابی میکروسکوپی بخش‌های مختلف در CNS بر روی ۲۰ گربه که یا به‌طور طبیعی مرده بودند یا به‌دلیل علائم عصبی عمل یوتانایز بر آن‌ها انجام شد. پس از کالبدگشایی، قسمت‌های مختلف CNS ازنظر هیستوپاتولوژی بررسی شد و آزمایش PCR به منظور غربالگری عفونت‌های ویروسی احتمالی، ازجمله پریتونیت عفونی گربه‌سانان (FIP)، ویروس نقص ایمنی گربه‌سانان (FIV) و ویروس لوسمی گربه سانان (FeLV) انجام شد.

نتایج: تغییرات هیستوپاتولوژیک شایع به‌ترتیب رخداد در گربه‌ها عبارت بودند از: مننژیت، PVC، انسفالیت، پرخونی، DIC ،ادم مننژ، مننگوانسفالیت گرانولوماتوز، نکروز حاد نورونی، نکروز آبکی، التهاب اپاندیم، ترومبوز و دمیلیناسیون. طبق نتایج به‌دست‌آمده از PCR بافت سیستم دستگاه عصبی، ۱۲ گربه مبتلا به FIP، ۵ گربه مبتلا به FIV و ۴ قلاده از گربه‌ها نیز به FeLV مبتلا بوده‌اند. در هیچ‌یک از موارد ضایعات هیستوپاتولوژیک منطبق با بیماری FSE(انسفالیت اسفنجی شکل گربه‌سانان) مشاهده نشد.

نتیجه‌گیری نهایی: براساس یافته‌های این مطالعه که برای اولین بار در ایران انجام شد، شایع‌ترین عوامل ویروسی که سیستم عصبی مرکزی را آلوده می‌کنند به‌ترتیب FIV، FIP و FeLV بوده است. یکی از دستاوردها و نوآوری‌های مهم در این تحقیق بررسی بیماری FSE بوده است که شواهدی از وقوع آن در بررسی‌های هیستوپاتولوژی مشاهده نشد.

کلیدواژه‌ها: دستگاه عصبی مرکزی، کالبدگشایی، گربه، هیستوپاتولوژی، PCR

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