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Cat diseases diagnosed in Korea, 2015～2017

Ji-Youl Jung, Kyunghyun Lee, Eun-Jin Choi*, Hyunkyoung Lee, Bo Youn Moon, Ha-Young Kim, ByungJae So

Animal Disease Diagnostic Division, Animal and Plant Quarantine Agency, Gimcheon 39660, Korea

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Abstract

There has recently been a growing demand for pathodiagnosis to determine the cause of death in cats. We retrospectively analyzed the diseases diagnosed in cats that were submitted to Animal and Plant Quarantine Agency (APQA) in 2015～2017. Overall diagnostic rate in feline samples was 85.2% (*n*=104/122). Among diagnosed cases, infectious diseases (*n*=63) were responsible for most of the feline diseases and feline panleukopenia (*n*=29) were most prevalent. Highly pathogenic avian influenza (HPAI) H5N6 was first diagnosed in cats at the end of December 2016 in the HPAI outbreaks. One case in 2015, 4 cases in 2016, and 14 cases in 2017 were associated with animal abuse, such as trauma and poisoning. These results suggest that suitable vaccination of feline infectious diseases, monitoring of the susceptible domestic animals during HPAI outbreaks, and interest on veterinary forensics to prevent and determine animal abuse are needed.

Key words : Animal abuse, Cat, Infectious disease, Pathodiagnosis

INTRODUCTION

In recent years, the number of cats has increased dramatically. According to a recent report from Korea Rural Economic Institute (KREI), the number of cats raised in Korea has increased from 436,000 in 2006 to 2,425,000 heads in 2017 (Ji et al, 2018). Socially, the point of view of the cat has also changed greatly. People began accepting cats as friends and family. When cat suddenly died, the number of people requesting pathological diagnosis increased. This is important for check of the cat's own health as well as for searching of infectious disease, especially zoonosis.

Animal and Plant Quarantine Agency (APQA) as the national veterinary diagnostic laboratory in Korea is diagnosing the samples submitted from local veterinary diagnostic laboratory, clinical veterinarian, parent, or association of animal protection. APQA has been diagnosed samples according to standard diagnostic guidelines (APQA, 2017). These guidelines include details such as diagnostic methods, sample preparation, pathological features of various diseases, and interpretation of results for antibody and antigen tests.

Previous reports have focused on single or complex diseases that are prevalent in cats, particularly the specific pathogenic or emerging agents of infectious diseases (Dubey et al, 2009). The study on parasite infectious diseases was the most frequent in cats. The prevalence of *Toxoplasma gondii*, zoonotic intestinal trematodes, *Dirofilaria immitis*, and *Bartonella* spp. as a new zoonotic pathogen were reported for mainly feral cats (Kim et al, 2008; Dubey et al, 2009; Kim et al, 2009; Park et al, 2014; Shin et al, 2015). Ghil et al (2009) reported high detection rate of *Helicobacter* spp. in domestic and feral cats and Song et al (2011) reported interspecies transmission of the canine influenza H3N2 virus to domestic cats. In addition, as reported in the study that *Lawsonia intracellularis* causing the pro-

*Corresponding author: Eun-Jin Choi, Tel. +82-54-912-0460, Fax. +82-54-912-0465, E-mail. choiej@korea.kr

liferative enteropathy of pigs was found in 5.2% of domestic cats with digestive disturbances, it has recently become very important as a potential source of new pathogens (Yeh et al, 2017).

To date, there has been no report on pathodiagnosis of dead cats in Korea. In this study, we describe the results of pathologic diagnosis in cats submitted to APQA in 2015～2017.

MATERIALS AND METHODS

Preparation of samples

A total of 122 cats were submitted to the Animal Disease Diagnostic Division, APQA in 2015～2017 to determine the cause of death. After observing the appearance of the whole body and the internal organs by necropsy, the organ and brain tissues, body fluids such as pleural fluid, ascites, gastric contents, and feces from cats were routinely collected. For virus examination, the tissues were chopped, homogenized, and prepared as 10% suspensions (v/v) in 0.8% saline. The suspensions were centrifuged for 15 min at 3,000×g, and the supernatants stored at −80℃ until use.

Histopathologic examination

All tissues were fixed in 10% neutral buffered formalin solution and embedded in paraffin wax. The embedded tissues were sectioned and subsequently stained with hematoxylin and eosin. The different stains including immunohistochemistry were also done if necessary. The lesion was observed by direct microscopy in the stained tissue.

Bacterial examination

Each sample was obtained from an individual animal and was collected from a variety of tissues, including the brain, organs, feces, and body fluids. The samples were cultured on agar medium. When colonies were observed after incubation, additional experiments were conducted according to standard diagnostic guidelines and veterinary manual to identify bacteria (APQA, 2017; MSD, 2018).

Virus examination

Viral nucleic acid (NA) was extracted from tissue samples using a DNeasy kit or an RNeasy Mini Kit (Qiagen, Hilden, Germany) according to the manufacturer's instructions and stored at −80℃ until analyzed. The isolated NA was used as template and amplified using viral detection kit (Intron, IP11176; Intron, IP11177; Intron, IP11178; Intron, IP12176; Intron, IP12177; Intron, IP12178) for feline immunodeficiency virus (FIV), feline herpesvirus virus (FHV), feline parvovirus

Table 1. Etiological analysis of diseases diagnosed in cats in 2015～2017

Etiology		Number of cases (%)			
		Year 2015	Year 2016	Year 2017	Total
Infectious	Bacterial	5 (12.8)	4 (11.8)	6 (12.2)	15 (12.3)
	Parasitic	0 (0)	1 (2.9)	1 (2.0)	2 (1.6)
	Viral	7 (17.9)	11 (32.4)	17 (34.7)	35 (28.7)
	Viral+Bacterial	5 (12.8)	5 (14.7)	1 (2.0)	11 (9.0)
	Subtotal	17 (43.6)	21 (61.8)	25 (51.0)	63 (51.6)
Noninfectious	Neoplastic	5 (12.8)	0 (0)	1 (2.0)	6 (4.9)
	Pathologic	6 (15.4)	7 (20.6)	3 (6.1)	16 (13.1)
	Toxic	0 (0)	0 (0)	4 (8.2)	4 (3.3)
	Traumatic	1 (2.6)	4 (11.8)	10 (20.4)	15 (12.3)
	Subtotal	12 (30.8)	11 (32.4)	18 (36.7)	41 (33.6)
Undermined		10 (25.6)	2 (5.9)	6 (12.2)	18 (14.8)
Total		39 (100.0)	34 (100.0)	49 (100.0)	122 (100.0)

(FPV), feline coronavirus (FCoV), feline leukemia virus (FeLV), and feline calicivirus (FCV). Cats with respiratory or neurological signs were tested for influenza virus (Intron, IPC11002) or rabies virus according to APQA's standard diagnostic guidelines, respectively (APQA, 2017). The products were analyzed by electrophoresis on 1.5% agarose gels, and visualized using ethidium bromide.

Parasite examination

The feces and intestinal contents were prepared by sucrose floatation method to observe the egg. The worms collected from intestines were identified using microscopy. Specific PCR was also performed if necessary for identification (APQA, 2017).

Toxic test

The gastric contents were checked for toxic substances. The substances include organophosphate insecticides, organochlorinated insecticides, carbamate insecticides, rodenticides, and cyanide, which can induce poisoning in livestock.

RESULTS

From the 122 cats that were analyzed in the study, the overall diagnostic rate was 104 (85.2%) in this study (Table 1). Infectious and noninfectious diseases in feline samples were diagnosed as 63 (51.6%) and 41 (33.6%) cases respectively. Among the infectious diseases, 46 cases were caused by viruses and feline panleukopenia was most prevalent (Table 2). Highly pathogenic avian influenza H5N6 was first diagnosed in three cats at the end of December 2016 in the HPAI epidemic. Noninfectious diseases were classified as neoplastic, traumatic, and toxic cause, and diseases diagnosed by pathological findings because the cause of infection was not found. Among them, traumatic was most frequently identified, except for diseases diagnosed as pathological approaches (Table 1). One case in 2015, 4 cases in 2016, and 14 cases in 2017 were evaluated for animal abuse such as trauma and poisoning (Table 3).

DISCUSSION

Various diseases have been diagnosed in cat samples submitted to APQA for the past three years. Especially infectious diseases accounted for more than half of the

Table 2. Infectious diseases diagnosed in cats in 2015~2017

Diagnosis	No. cases
Abscess	1
Ascariasis	1
Bacterial pleuropneumonia	1
Chronic inflammation	1
Coronaviral enteritis	1
Detection of feline parvovirus	1
Feline calicivirus infection	1
Feline calicivirus infection, Chronic nephritis	1
Feline infectious peritonitis	5
Feline infectious peritonitis, Septicemia	1
Feline panleukopenia	15
Feline panleukopenia, Bacterial pneumonia	2
Feline panleukopenia, Bacterial pneumonia, Bacterial enteritis	1
Feline panleukopenia, Clostridial enteritis	1
Feline panleukopenia, Colibacillosis, Bacterial pneumonia	3
Feline panleukopenia, Coronaviral enteritis	2
Feline panleukopenia, E. coli infection, hemothorax	1
Feline panleukopenia, Feline calicivirus infection	1
Feline panleukopenia, Feline calicivirus infection, Pneumonia by *E. coli*	1
Feline panleukopenia, Pneumonia by *Pasteurella* spp.	1
Feline panleukopenia, Septicemia	1
Highly pathogenic avian influenza	3
Necrotic enteritis	1
Necrotic enteritis, Interstitial pneumonia	1
Nonsuppurative interstitial pneumonia, Necrotic hepatitis	1
Nonsuppurative meningoencephalitis	1
Nonsuppurative myocarditis	1
Parasitic infection	1
Pneumonia by *E. coli*	1
Pneumonia by *Pasteurella* spp.	1
Pneumonia by *Pasteurella* spp., Pneumonia by *Streptococcus* spp.	1
Pneumonia by Streptococcus spp.	4
Salmonellosis	1
Septicemia	1
Suppurative inflammation	1
Suppurative interstitial bronchopneumonia, Suppurative pyelonephritis	1
Total	63

Table 3. Cases of animal abuse diagnosed in cats in 2015～2017

Year	Type	Diagnosis (No. cases)
2015	Traumatic	Trauma (1)
2016	Traumatic	Pulmonary hemorrhage (1), Hemoperitoneum (1), Hemorrhage (1), Trauma (1)
2017	Traumatic	Head injury (2), Hemoperitoneum (2), Chest trauma (2), Trauma (3), Hepatic rupture (1)
	Toxic	Carbon monoxide poisoning (1), Diazinon and Terbufos poisoning (1), Endosulfan poisoning (1), Rodenticide poisoning (1)

deaths of cats. Some reports suggest that feral cats are more susceptible to infectious diseases than domestic cats (Gerhold and Jessup, 2013). Many of infectious diseases are controlled in cats belonging to responsible owners through routine veterinary care, proper vaccination regimens and parasite chemotheraphy (Greene, 2012). Feral cats often lack the necessary preventative care to control these diseases and consequently pose a potential health threat to other domestic animals, wildlife and humans. Free-roaming cats are also reported to be an important source of zoonotic diseases including rabies, *Toxoplasma gondii*, cutaneous larval migrans because of various nematode parasites, plague, tularemia, and murine typhus (Gerhold and Jessup, 2013). Unfortunately, we could not distinguish between domestic cats and feral cats in this study, so we could not compare the types and differences of diseases.

FCoV, FCV, FeLV, FHV, FIV, and FPV are known viruses that mainly cause diseases in cats (Greene, 2012; Möstl et al, 2013). Our laboratories have routinely inspected these six viruses and, if necessary, carry out additional tests for different viruses such as rabies and influenza virus. In this study, feline panleukopenia as a FPV infection was the most frequently detected and thought to cause many problems in the field. Followed by feline infectious peritonitis and coronavirus enteritis caused by FCoV and FCV infection was diagnosed. Interestingly, none of the FeLV, FHV, and FIV infections were identified. In the future, it is necessary to prove whether there are viruses in Korea or not yet detected in our samples even though they are present.

The causative agents of bacterial diseases identified in this study were *E. coli*, *Pasteurella*, *Streptococcus*, *Clostridium*, and *Salmonella*, which were found to affect respiratory and digestive systems evenly (Table 2). Very few cases of parasitic infections were detected (2 cases). This is because larvae or eggs were observed, but they were not considered to be a direct cause of death.

In this study, HPAI was the only searched zoonosis and the first confirmed disease in cat in Korea. The cat's owner stated the cat had eaten wild bird carcasses and founded in the radius of one kilometer from the area with reported seven HPAI H5N6 infections in chicken farm and habitat for migratory birds. The cats were observed severe pulmonary congestion and edema, and necrosis of neurons in cerebrum and cerebellum. The H5N6 viruses were detected in many tissues by IHC, and were identified by RT-PCR and sequencing (Data not shown because the related research article submitted). This highlights the need for monitoring the susceptible domestic animals including cat during H5N6 outbreaks.

In recent years, there has been a significant increase in the number of parents and associates who want to have a forensic diagnosis because they think that a cat is dead because of animal abuse. Animal abuse generally includes physical abuse (non-accidental injury), sexual abuse, emotional abuse, neglect, and staging animal fights (Jung et al, 2018). There is no veterinary forensic science institution in Korea, nor does it have veterinary forensic research system. It is now the stage that begins to take an interest in animal physical abuse using a pathological approach in the veterinary pathology laboratory. In the last three years, 1 case in 2015, 4 cases in 2016, and 14 cases in 2017 were evaluated as physical abuse: Most were trauma, and some poisoning was included.

These results suggest that suitable vaccination of feline infectious diseases, monitoring of the susceptible domestic animals during HPAI outbreaks, and interest on veterinary forensics to prevent and determine animal abuse are needed.

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