

Review

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Overview of feline infectious peritonitis: Comparison of ocular manifestations with COVID-19

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Abstract

Coronaviruses have been known to infect wild and domestic animals and humans. The infections caused by these viruses may involve different organs and systems both in animals and humans. Ocular involvement by coronaviruses have been demonstrated in animals. The ocular involvement in humans has yet to be clarified particularly in Sars-Coronavirus-2 (Sars-CoV-2) infection. In this review, we will discuss the ocular signs of feline coronavirus leading to feline infectious peritonitis (FIP) in felids and Sars-CoV-2 causing COVID-19. We will look into similarities and differences.

Introduction

Coronaviruses (CoVs) are referred to as enveloped viruses having single-strand of positive-sense RNA. CoVs are classified within four genera which called Alphacoronavirus, Beta coronavirus, Gamma coronavirus and Delta coronavirus, recognizing birds, bats, and rodents (1). Corona viral diseases are commonly known in veterinary medicine whereas wild and domestic species are affected by different types of CoVs (2-4).

The feline coronavirus (FCoV) emerges in two distinct pathotypes. The two pathotypes have

been considered as distinct viral species for a long time. However, it has been demonstrated that these two variants belong to the same virus but having different virulence (5).

The characteristics of feline infectious peritonitis

The feline enteric coronavirus (FECV) commonly occurs in multi-cat environments and is extremely contagious. Nevertheless, this type of infection is mostly asymptomatic or it sometimes causes only diarrhea (6-8). FIPV emerges as a result of mutation of the avirulent FECV within a small percentage of infected cats and following that, it leads to the fatal disease referred to as FIP (9-11). 7-14% of cats infected with the coronavirus develop fatal feline infectious peritonitis (FIP). The genes hosting the mutation(s) that causes FIPV development is not known yet exactly (12). While the FEVC is infectious by means of the fecal-oral route, the feline infectious peritonitis virus (FIPV) is not. The rate of seroprevalence decreases to 21% in single-cat households, on the other hand, it increases up to 90% and more in multicat households and shelters. (13, 14).

FIP generally occurs in young cats under the age of two years (15). Host factors such as genetic background and maturity contributing to the immune response, presumably have a

significant role in the development of FIP (5, 6, 16-19). Environmental factors such as caring more than one cat in the same house, surgical operations, and shelter conditions will increase the stress level and cause an increase in the viral replication rate in cats (20).

Non-specific clinical signs such as anorexia, fever, gait disorders, and changes in behavioral are observed. FIP is characterized by two main forms. In the non-effusive form (dry), granulomatous lesions and vasculitis are observed in the kidney, colon, caecum, lung, liver, lymph nodes, central nervous system, and eye. In the effusive form (wet), protein-rich fibrinous inflammatory fluid accumulation is observed in the chest, abdominal cavity, pericardium, and testicles. Following the initial infection and the triggering stress, the disease emerges in weeks to any months and this dry form of FIP is more chronic manifestation (21-24).

Ocular signs of FIP and COVID-19

Approximately 36% of cats diagnosed with non-effusive (dry) FIP have been reported to have ocular lesions. The most common clinical finding in the eye; is damage to the uveal region resulting in iritis, uveitis, or chorioretinitis. This condition can also be accompanied by retinal hemorrhage, detachment, or panophthalmitis (5). Since the accumulation of fibrin, macrophage, and other inflammatory cells formed in the caudal part of the cornea causes keratic precipitates, the first symptom noticed in the eye form is a discoloration in the iris. Usually entire or part of the iris turns into brown, although occasionally blue eyes becomes green. Iritis may also manifest itself as aqueous flare. Although ocular FIP is one of the most important causes of idiopathic uveitis, Toxoplasmosis, FeLV, and traumas should be evaluated in the differential diagnosis. When aqueocentesis is performed, neutrophils are observed to be predominant in the field in cats with FIP. In idiopathic uveitis, reactive lymphocytes and plasma cells dominate the

field, but this still does not provide an accurate diagnosis (25-29).

In humans, Sars-CoV-2 causing COVID-19 mainly affects respiratory system. The hepatic, neurologic and gastrointestinal manifestations also have been described. It is evident that that cellulular tropism of FCoV and Sars-CoV-2 are different. Though they are similar in some virologic and epidemiological aspects, the pathologic mechanism of the diseases differ (29). They bind to different receptors. FCoV binds to feline aminopeptidase N and cell membrane lectins to facilitate the virus entry whereas Sars-CoV-2 binds to ACE2 receptors in the body (29, 30). This may account for the fact that they affect organ systems to varying degrees. It has been reported that epithelia of conjunctiva and cornea, retina, enterocytes of the small intestine, respiratory system and the proximal tubules of the kidney have the same ACE2 receptors for COVID-19 (31). The eye may be involved in COVID-19 infection like in FIP. The main ocular manifestation reported in COVID-19 infection is conjunctivitis (32). In FIP, 90 % of the felines and their offspring have conjunctival FCoV antigen positivity and may develop conjunctivitis (33). Unlike FIP, in which the most common ocular manifestation is uveitis, uveitis associated with COVID-19 have been defined in a few cases (34). Both anterior and posterior and intermediate uveitis were described (35, 36). Changes in retinal vasculature and choroid also have been reported in COVID-19 patients (37, 38). Yet, the exact mechanisms and immunopathogenesis leading to vascular changes has to be defined. Hyperreflective lesions at the level of ganglion cell and inner plexiform layer of the retina have also been described in the literature (39).

The ophthalmic manifestations of COVID-19 have been associated with the severity of the systemic disease (40). A cytokine storm syndrome is usually observed in humans infected with Covid-19 and in cats affected by FIP (41). In FIP, there is a rapid innate immune response producing proinflammatory cytokines followed by worsening of the clinical

condition and laboratory markers. The cytokines in COVID 19 are similar to those of FIP. The suppression of hyperinflammation both in COVID-19 and FIP provide relief.

In conclusion, feline CoVs can cause ocular implications through variable mechanisms. Some of these mechanisms are totally different from those of human CoVs. CoVs may lead to ocular manifestations affecting all the components of the eye. One of the latest interesting manifestation reported in COVID-19 is the loss of ocular surface sensation (42). CoVs can also develop in-vivo mutations which alter the manifestations of the disease (43). Therefore we may encounter other ocular and systemic manifestations due to CoVs.

The long-term experience gained through FIP in veterinary medicine could help to comprehend Covid-19.

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