REVIEW ARTICLE

ARTICLE RÉVISÉ

Acquired Hydrocephalus and Hydromyelia in a Cat with Feline Infectious Peritonitis: A Case Report and Brief Review

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Abstract

A one-year-old domestic long-haired cat was referred to the New York State College of Veterinary Medicine because of acute onset of paraparesis and hyperesthesia associated with trauma. Myelography and cerebrospinal fluid analysis revealed severe hydromyelia and myelitis, respectively. The definitive diagnosis of feline infectious peritonitis was made by histological examination at necropsy. Lesions were confined exclusively to the brain and spinal cord. Partial occlusion of the third and fourth ventricles with pyogranulomatous debris caused hydrocephalus and subsequent hydromyelia. The hydromyelia may have been the primary means of compensation for the hydrocephalus, thus masking subclinical disease.

Résumé

Hydrocéphalie aquise et hydromyélie chez un chat atteint de péritonite infectieuse: présentation d'un cas et revue de la littérature

Un chat domestique à poil long d'un an fut admis au New York State College of Veterinary Medicine pour une paraparésie et une hyperesthésie aiguës consécutives à un traumatisme. La myélographie et l'analyse du liquide céphalo-rachidien ont démontré respectivement une hydromyélie sévère et une myélite. Le diagnostic final de péritonite infectieuse fut établi par histopathologie à la nécropsie. Les lésions se retrouvaient exclusivement au cervau et à la moelle épinière. L'hydrocéphalie et l'hydromyélie consécutive résultaient d'une obstruction partielle des 3e et 4e ventricules par des débris pyogranulomateux. L'hydromyélie serait probablement un mécanisme de compensation important pour l'hydrocéphalie ce qui avait pour effet de rendre l'anomalie asymptomatique.

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Introduction

The neurological form of feline infectious peritonitis (FIP) involving the central nervous system (CNS) and eyes (uveal tract) has been well documented (1-5,7). Neurological involvement is thought to be about three times more prevalent in the noneffusive form of FIP compared to the more typical effusive form (3,8). Immune complex-mediated vasculitis is thought to be responsible for the nervous system lesions (1-8). Some cats do not show neurological deficits despite histological evidence of CNS involvement (3).

In this paper, we review the literature and describe the clinical and necropsy findings in a one-year-old domestic long-haired cat with the neurological form of FIP.

Literature Review

Feline infectious peritonitis (FIP) is a fatal multisystemic disease of domestic and some wild felidae caused by a coronavirus (1-4). The disease is seen primarily in cats between six months and five years of age and there is no sex predilection (1-4). Feline infectious peritonitis is a chronic, slowly progressive disease, and clinical signs are often nonspecific. Variability in the presenting clinical features depends on the dosage or strain of virus, host response, and organ involvement (4,5,7). Stressful situations have been observed to activate subclinical disease (4). There is evidence to suggest that, in a certain percentage of cats, initial exposure to FIP virus results in a localized upper respiratory disease that is usually mild (10). The majority of cats undergoing this "primary" disease recover, while others become chronically infected carriers. A small number of the exposed cats proceed to the lethal, disseminated ("secondary") form of the disease (10). The effusive (wet) form of FIP results in the outflowing of protein-rich fluid into the peritoneal and/or pleural cavities. The noneffusive (dry) form consists of granulomatous lesions, primarily in parenchymatous organs, with minimal exudation (1-4,8).

Brain lesions of FIP are generally surface-related and involve the meninges, choroid plexuses, and ependyma to a much greater degree than the brain parenchyma (3,6-9). The exudate that occurs is composed of protein-rich edema fluid and fibrin, with necrotic debris and inflammatory cells (2,7). The ependymal surface of the third and fourth ventricles is often the most severely affected. Deeper lesions often surround blood vessels or are adjacent to surface

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lesions in the meninges or ventricular system. Disease of the choroid plexus and ventricular ependyma can obstruct the CSF circulation causing hydrocephalus (2,7,9).

Spinal cord lesions are usually less common but similar in nature to the brain lesions (7). Focal spinal meningitis is usually accompanied by inflammation around the central canal or along vessels (6,7). The spinal cord parenchyma is usually spared except for reactive perivascular cuffs and glial nodules (7). Histologically, the CNS lesions are characterized by an infiltration of neutrophils, macrophages, plasma cells, and lymphocytes (5–7,9).

The most common neurological signs observed with FIP include paraparesis, incoordination, hyperesthesia, nystagmus, and convulsions (2–4,8). Other signs include anisocoria, tetraparesis and generalized ataxia, cranial and peripheral nerve paralysis (1,3–5). The neurological signs are frequently accompanied by fever, depression, weight loss, or other signs of chronic systemic illness (1,2,5,7,8).

Cerebrospinal fluid is abnormal in cats with extensive meningeal involvement, but may be normal with focal or localized subependymal lesions. The CSF of cats with FIP meningitis contains many leukocytes and an elevated protein concentration. Neutrophils or lymphocytes may predominate the pleocytosis (1–4).

Diagnosis is made by histopathological evaluation. High FIP titers may indicate recent or active exposure but cross-reactivity with other coronaviruses makes interpretation of titers challenging (1,10–12).

Case History

A one-year-old 3.6 kg castrated male domestic longhaired cat was referred to the New York State College of Veterinary Medicine because of paraparesis first noticed two days after the owner had inadvertently stepped on the cat. Precise anatomical location for the site of trauma could not be made because the cat quickly ran away. The signs were progressive and reported to be marginally responsive to amoxicillin and dexamethasone. The cat became anorectic. Additionally, the cat had a history of ear mites and chronic upper respiratory infections. Vaccination status for rabies, panleukopenia, and respiratory viruses was current. A feline leukemia virus (FeLV) ELISA was negative.

Clinical Findings

On physical examination, ten days after the onset of paraparesis, the cat was alert, responsive and slightly dehydrated. The cat was unable or unwilling to move the hindlimbs and kept them flexed under the abdomen. Hyperesthesia was noted from the mid-thoracic region caudally. The thoracic limbs were neurologically normal. The pelvic limbs were difficult to assess neurologically because of hyperflexion and intense pain on palpation. Occasional movement of the pelvic limbs was noted. Cranial nerve reflexes were normal. Ocular examination, including funduscopic evaluation, did not reveal any abnormalities. Femoral pulse quality was normal bilaterally. Differential diagnoses included a T3-L3 spinal cord lesion associated with spinal cord contusion, vertebral fracture or disc extrusion; myelitis; discospondylitis; neoplasia; and musculoskeletal disorders such as pelvic fracture, myositis, arthritis, or steatitis. Feline hyperesthesia syndrome was also a consideration.

Survey radiographs of the abdomen, pelvis, and vertebral column were normal. Abnormal hematological and serum biochemical values included moderate neutrophilic leukocytosis (19.6×10^9 neutrophils/L; normal is $2.5–12.5 \times 10^9$/L), mild lymphopenia (1.3×10^9/L; normal is $1.5–7.0 \times 10^9$/L), and mild hyperproteinemia (86 g/L; normal is 59–76 g/L) due to hyperalbuminemia (42 g/L; normal is 31–39 g/L) and hyperglobulinemia (44 g/L; normal is 23–41 g/L). These abnormalities were attributed to dehydration and stress. Creatine kinase activity was increased (337 U/L; normal is 15–157 U/L) suggesting muscle injury. Other blood values were normal. A repeat FeLV ELISA was negative.

Following rehydration with isotonic fluids, the cat was anesthetized for a cerebrospinal fluid (CSF) tap and myelogram. A lumbar CSF specimen was obtained at L5–6. Myelography was performed by injecting 0.75 mL of Metrizamide (Analytical grade. Accurate Chemical-Scientific, 300 Shames Dr., Westbury, New York) into the CSF collection site. The majority of the contrast medium filled the central canal which was dilated from midthorax to L7. There were numerous $\leq$ 1 mm nodular filling defects present throughout the central canal (Figure 1). In the lumbar area the subarachnoid space was narrowed but not deviated, compatible with diffuse cord swelling. The CSF contained 0.422×10^9/L red blood cells (normal is $< 0.005 \times 10^9$/L), and 0.099×10^9/L nucleated cells (normal is $< 0.005 \times 10^9$/L). The nucleated cells were predominantly neutrophils, but lymphocytes and macrophages were also present. The CSF protein was 11.70 g/L (normal is <0.20 g/L). These findings were consistent with diffuse myelitis and hydromyelia. Myelitis induced by feline infectious peritonitis was suspected.

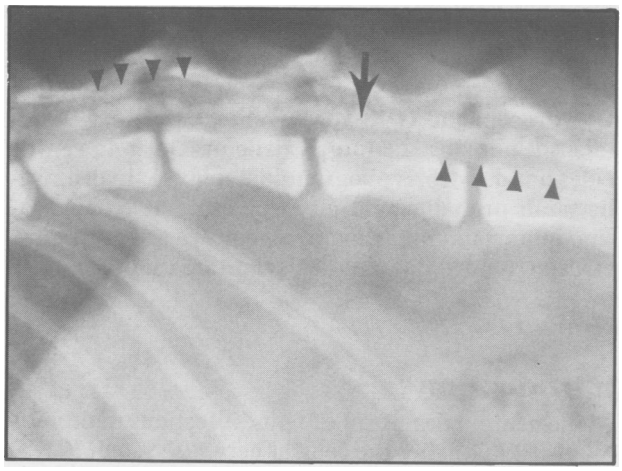

Figure 1. Lateral view of the myelogram at the thoracolumbar region in a cat with paraparesis. Contrast medium is present in the subarachnoid space (arrowheads) and within the central canal (arrow). The central canal is dilated and has multiple filling defects. (The circular background pattern on the film is due to a heating pad).

Owing to the poor prognosis, the owner requested that the cat be euthanized. Feline infectious peritonitis (FIP) titers (kinetic based ELISA [KELA]) obtained from harvested serum and CSF were 1:319 and 1:23 respectively. Titers >1:3200 suggest recent or active exposure to FIP virus, <1:3200 can be due to cross-reaction with enteric coronavirus (1).

Pathology

At necropsy, lesions were confined to the brain and spinal cord. Pale yellow exudate surrounded the caudal portion of the medulla oblongata and the first cervical spinal cord segment. The caudal portion of the cerebellar vermis was moderately coned.

On transverse section, both lateral ventricles were mildly dilated and the choroid plexuses were thickened. The choroid plexus of the third ventricle was slightly thickened and the ventral portion of the third ventricle was partly occluded. The mesencephalic aqueduct was occluded rostrally. The fourth ventricle was partly occluded and the choroid plexus was slightly yellow and markedly enlarged (Figure 2).

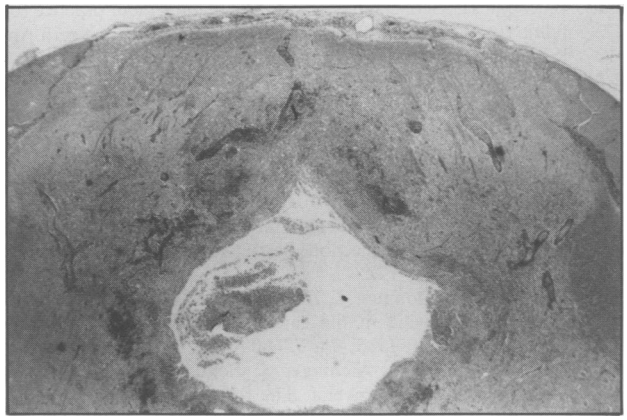

Figure 2. Transverse brain sections with mild dilation of the lateral ventricles, mild thickening of the choroid plexuses (left), and occlusion of the rostral aspect of the mesencephalic aqueduct (right).

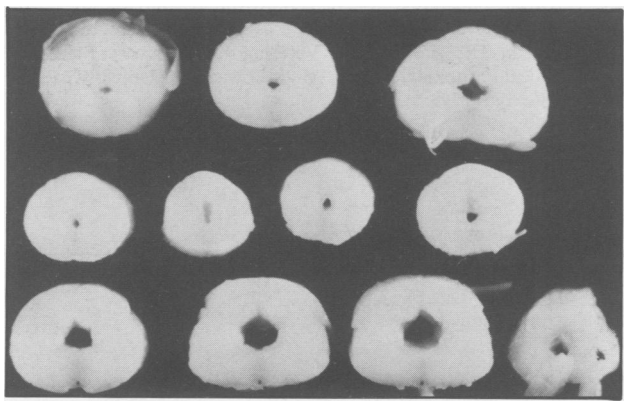

Figure 3. Transverse spinal cord sections with minimal dilation of the central canal in the cervical (top row) and thoracic (middle row) spinal cord and marked dilation of the central canal in the lumbar (bottom row) spinal cord.

Transverse sections of the spinal cord revealed slight dilation of the central canal beginning at C4. Within segments C5 to C8, the central canal was moderately dilated and irregular on longitudinal section. The thoracic and cranial lumbar segments had mild dilation of the central canal. The central canal of segments L5 to S1 was markedly dilated (2 mm wide by 3 mm high) with an irregular surface (Figure 3).

Histological examination of the CNS revealed chronic severe lymphocytic choroid plexitis. Additionally, within the brain and spinal cord there was severe pyogranulomatous meningitis and myelitis with ependymitis, perivascular lymphocytic/monocytic cuffing, and marked hydromyelia (Figure 4). Gomori's methenamine silver, Gram's, and Ziehl-Neelsen acid-fast stains were negative for fungi, bacteria and *Mycobacterium* spp., respectively. The histopathological findings were consistent with feline infectious peritonitis.

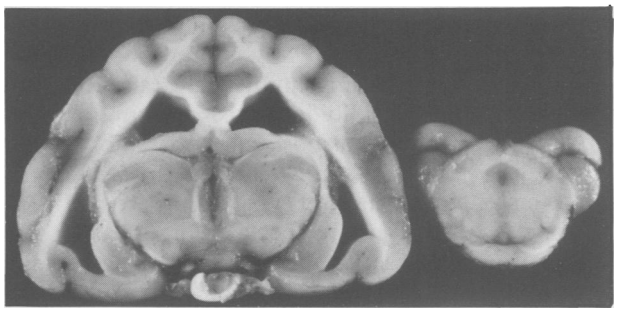

Figure 4. Lumbar spinal cord with severe lymphocytic/plasmacytic meningitis and ependymitis with perivascular lymphocytic/monocytic cuffing and marked hydromyelia. H & E stain.

Discussion

The case presented herein is interesting because the acute onset of clinical signs and the absence of other signs (fever, weight loss) were not typical of FIP. Also, the clinical signs (paraparesis and hyperesthesia) were caused by lesions confined primarily to the spinal cord.

Based on the extensive lesions, FIP infection was thought to be chronic. Partial occlusion of the third and fourth ventricles with pyogranulomatous necrotic debris caused the hydrocephalus and subsequent hydromyelia. What caused the rather acute onset of clinical signs is unknown; however, stress has been reported to exacerbate subclinical disease (4).

Hydrocephalus, hydromyelia, and syringomyelia have been experimentally induced in the cat and dog by intracisternal injection of irritating substances (e.g. kaolin) that cause chronic adhesive arachnoiditis (13–18). These adhesions will eventually obliterate the exit foramina of the fourth ventricle and cause hydrocephalus (13–18). In the cat, hydrocephalus was apparent at two weeks post-injection and the central canal was dilated up to 40 times its normal diameter at four to six weeks (14).

Communication between the fourth ventricle and the central canal in nonhuman mammals is normally closed by a thin membrane and there is a minimal but continuous flow of CSF into the central canal (16,18). This membrane is broken down following the onset of hydrocephalus and communication is rapidly established between the ventricles and the central canal (18).

The ability of the central canal to open is probably greatest in the young (15).

It was noted, in cats with experimentally induced hydrocephalus (kaolin or surgical ligation), that dilation of the central canal improved the conditions caused by raised intracranial pressure (16). This suggested that the dilated central canal acts as a kind of natural by-pass, draining the CSF from the ventricles into the spinal subarachnoid space (16).

The hydromyelia in this cat may have resulted indirectly from the extension of the elevated intraventricular pressure in the brain via the communication of the central canal with the fourth ventricle. It also could have developed as a direct result of the disease process on the ependymal surface of the central canal and adjacent parenchyma. The hydromyelia in this young cat may have been the primary means of compensation for the hydrocephalus thus masking subclinical disease.

Other diseases causing multifocal granulomatous lesions include coccidioidomycosis, histoplasmosis, cryptococcosis, toxoplasmosis and tuberculosis (4,5). These diseases do not cause the marked exudation of protein seen with FIP, and organisms were not identified histologically using special stains.

Creatine kinase is highly concentrated in skeletal muscle, cardiac and nervous tissue (19,20). The elevated value in this case may have been related to muscle damage sustained from trauma or to destruction of neurological tissue (19,20). Analysis of CSF creatine kinase may have been useful. The CSF findings of an increased protein and pleocytosis are consistent with feline infectious peritonitis; however, histopathology was necessary for the definitive diagnosis.

Feline infectious peritonitis titers are difficult to interpret because of cross-reactivity with other coronaviruses. The low FIP titer in the case herein, despite the presence of severe disseminated lesions, may indicate the terminal stage of the disease, a very rapid disease process, or the end of the seroconversion phase (10–12). With extensive immune complexing, it is conceivable that there is little free, unbound coronavirus antibody available to be detected (11,12).

Acknowledgments

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