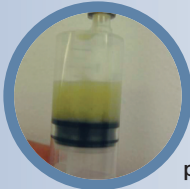




FELINE BILIARY TREE AND GALLBLADDER DISEASE

Aetiology, diagnosis and treatment

Corma MA Otte, Louis C Penning and Jan Rothuizen



Practical relevance: Diseases of the biliary tree and gallbladder are more common in cats than diseases of the liver parenchyma. The parenchyma is usually affected

secondarily to systemic illnesses, while the biliary system is the prime target for infectious agents (eg, bacteria and flukes) and non-infectious conditions (eg, neoplasia and cysts).

Clinical approaches: Cats with biliary disease are evaluated because of common feline clinical signs such as anorexia, nausea, vomiting and lethargy. Icterus may or may not be obvious. Biopsies for histological evaluation, and bile aspirates for culture and cytological evaluation are helpful diagnostically. Antibiotics and immunosuppressive drugs have been used successfully. Hepatosupportive drugs may help in liquefying thick bile and protecting hepatic tissue from damage. Ultrasound is a non-invasive diagnostic tool that may help in identifying dilated bile ducts, liver cysts and choleliths. It is also used to guide percutaneous bile aspiration.

Audience: This review, written for all veterinarians who treat cats, describes the various conditions that can affect the feline biliary tree and gallbladder. Treatment options are discussed, and brief summaries provided of surgical techniques and diagnostic approaches.

Evidence base: The veterinary literature pertaining to feline biliary disease is comprehensively reviewed. When appropriate, data on dogs and humans has been included to provide background information. Based on the available literature, more research into feline biliary diseases is needed.

The healthy liver

The first embryonic function of the liver is haematopoiesis.¹ Upon maturation, the liver has critical functions in metabolism and detoxification, including synthesis of proteins such as albumin and blood clotting factors, maintenance of glucose homeostasis, lipid metabolism, conjugation and excretion of endogenous and exogenous toxins and drugs, and excretion of bile.^{2,3}

The feline liver is the largest internal organ, corresponding to approximately 3–4% of total body weight.^{4,5} Parenchymal liver diseases include lipidoses, amyloidosis and feline infectious peritonitis (FIP). In these diseases, the liver parenchyma is not the primary target, but is affected as part of the systemic disease. In cats, it is the biliary system rather than the liver parenchyma that is the primary target of disease.

Feline bile (pH 5.9–7.8) is a fluid consisting of various (non-)sulphated bile acids and cholesterol.^{6,7} Taurine is the only nutrient used by cats to conjugate bile acids and, because cats have limited taurine production capacity, it is considered an essential dietary component for cats.^{6,8} Thus taurine availability can also be considered a limiting factor in the production of conjugated bile acids.

Bile salts are excreted into specialised regions of the canalicular membrane between hepatocytes: the bile canaliculi (see diagram on page 515). The bile canaliculi drain into the canals of Hering, which merge to create interlobular bile ducts, and later fuse into intrahepatic bile ducts. These join to form hepatic ducts and, ultimately, the common bile duct (CBD). Together with the cystic duct, this network is considered to be the biliary tree. The biliary tree and gallbladder constitute the biliary system. At Vater's papilla, the CBD enters the duodenum.^{9–11} In cats, the major pancreatic duct usually joins the CBD before it enters the duodenum; only 20% of cats are estimated to have an accessory pancreatic duct with its own separate opening into the duodenum.¹²

In cats, it is the biliary system, rather than the liver parenchyma, that is the primary target of disease.



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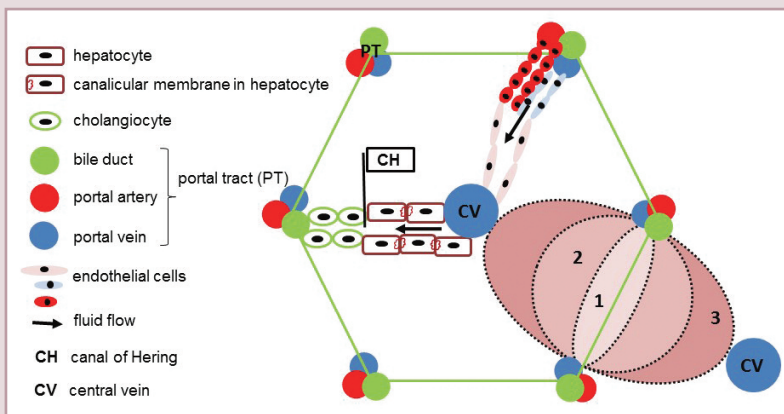
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SAGE

Diagrammatic representation of liver microanatomy and function

In terms of its **microanatomy** the liver is traditionally described as consisting of hexagonal hepatic lobules (one lobule is shown in green on the left of the diagram).² In this view, blood flows from the portal vein (blue) and hepatic artery (red) to the central vein (CV). This clearly demonstrates a unique feature of the liver, which is the dual blood supply: the liver receives venous blood from the gastrointestinal tract and arterial blood via the hepatic artery. The portal tracts (PT) are completed by a bile duct (green)



A more **functional** representation of the liver is obtained by describing the smallest functional units of the liver: the hepatic acini (one acinus is shown in pink on the right of the diagram).² Zone 1 centres on the portal tract and receives the most oxygen-rich blood. Zone 3, by contrast, receives less oxygen because it is further away from the portal tract. Therefore, zone 3 is more susceptible to hypoxia, while zone 1 is more likely to suffer direct toxic damage

The hepatic ducts transport bile into the gallbladder, where the fluid is stored and concentrated during fasting. The duodenal mucosa produces cholecystokinin when food enters the intestines, the hormone that stimulates the gallbladder to contract. Bile enters the duodenum via the CBD and mixes with food. Bile acids aid in digestion and absorption of lipids and fat-soluble vitamins. Bile is also used to eliminate many waste and toxic products, which are subsequently excreted in the faeces. About 90% of bile acids are reabsorbed in the enterohepatic circulation.⁷

Felids have a low capacity for glucuronide conjugation of drugs and toxins, limiting their conversion to water-soluble substances that can be excreted into urine or bile.¹³ This makes cats more prone to suffer hepatotoxic effects when exposed to certain drugs and toxins (see box above for commonly used drugs that are hepatotoxic to cats).

A detailed report, almost a century ago, by Boyden showed that over 12% of cats have some sort of accessory gallbladder (see later).¹⁷ However, biliary disease and gallbladder anomalies are infrequently reported together, which suggests that there is no association between the two.¹⁸

Cholestasis

An important clinical syndrome associated with biliary disease is cholestasis, which is defined as impaired bile flow.¹⁹ Cholestasis is not a disease per se, but a pathophysiological phenomenon associated with dysfunction of

Hepatotoxic drugs commonly used in practice

- ✦ Methimazole³
- ✦ Carbimazole³
- ✦ Oral diazepam⁹
- ✦ Acetaminophen (paracetamol)¹⁴
- ✦ Ciclosporin A and cloxacillin¹⁵
- ✦ Rifampicin¹⁵
- ✦ Cloxacillin¹⁵
- ✦ Itraconazole¹⁶
- ✦ Ketoconazole¹⁶
- ✦ Tetracycline¹⁶
- ✦ Glipizide¹⁶
- ✦ Stanozolol¹⁶

the biliary system. Two forms are commonly distinguished – intrahepatic and extrahepatic.

✦ **Intrahepatic cholestasis** occurs predominantly at the level of hepatocytes, bile canaliculi or bile ductuli in zone 1 (see diagram above). In cats, intrahepatic cholestasis is linked to the destruction of bile ductuli and hepatic fibrosis secondary to cholangitis.¹⁸ Some cholestatic drugs (eg, methimazole, ciclosporin, rifampicin and cloxacillin) have been associated with reduced bile flow at the canalicular level.^{3,15} In all species, dogs and humans included, endotoxins represent a major cause of intrahepatic cholestasis by impairment of the canalicular bile flow.²⁰

✦ **Extrahepatic cholestasis** is caused by obstruction of the CBD.



Figure 1 Icterus observed (a) in the ear and (b) on the skin of the ventral neck. Images courtesy of (a) Dr Robert Favier, Utrecht University, and (b) Marleen Assink

Extrahepatic bile duct obstruction

Aetiology

Bile sludge and choleliths, associated with cholangitis, cholecystitis and impaired contractility of the gallbladder, have been implicated as the most common causes of extrahepatic bile duct obstruction (EHBDO).^{21–23} Other causes include pancreatitis,^{12,22} biliary neoplasia,²² foreign bodies,^{21,24} biliary mucoceles¹⁸ and gastrointestinal disease.²³

Clinical signs

Clinical signs appear to be non-specific in relation to the cause of cholestasis and include

Combined extra- and intrahepatic cholestasis

While two forms of cholestasis are described, in practice there is often a combination of extra- and intrahepatic cholestasis. Obstruction of the CBD affects the entire biliary tree but is described as extrahepatic cholestasis. In contrast, in inflammatory biliary diseases the entire bile system is involved; however, the predominant features occur in the smallest branches of the system and so these forms are described as intrahepatic cholestasis.

abdominal pain, vomiting, dehydration, nausea, anorexia, weight loss, lethargy, pyrexia, icterus (Figure 1), diarrhoea and polyuria/polydipsia.^{12,18,21–24} Although acholic faeces

Table 1 Biochemical profile: commonly encountered laboratory findings in biliary disease^{14,25} (continued on page 517)

Parameter	Anatomical distribution	Increases in response to:	t _{1/2}	Increases observed:	Decreases observed:	Especially useful in:	Findings in biliary and gallbladder diseases (with supporting references)
Alanine aminotransferase* (ALT)	Cytosol of hepatocytes, cardiac muscle, kidney	Hepatocellular necrosis, inflammation, acetaminophen toxicosis	3.5 h	In first 5 days after injury (within 24 h in acetaminophen toxicosis)	2–3 weeks after recovery (within 72 h in acetaminophen toxicosis)	–	<ul style="list-style-type: none"> ✦ Biliary cyst, cholecystitis and NC^{26,27} ✦ LC^{27–29} ✦ Choledochal cyst³⁰ ✦ AD-PKD³¹ ✦ EHBDO^{22,24} ✦ Gallbladder sludge²³ ✦ Cholelith^{12,32–34} ✦ Avulsion of CBD¹² ✦ Cholestasis¹² ✦ Hepatic lipidosis¹⁸ ✦ Non-specified hepatobiliary disease³⁵ ✦ Cholangitis³⁶ ✦ LFC^{37,38} ✦ Gallbladder mucocele and lipidosis³⁹ ✦ Cholecystitis, cholelith, gallbladder rupture and peritonitis⁴⁰ ✦ Hepatocellular carcinoma⁴¹
Aspartate aminotransferase† (AST)	Cytosol and mitochondria of hepatocytes, skeletal muscle, heart, kidney, brain, small intestine, spleen	–	1.5 h	In first 3 days after injury	2–3 weeks after recovery	Hepatic necrosis, cholangitis, chronic bile duct obstruction	<ul style="list-style-type: none"> ✦ Biliary cyst, cholecystitis and NC^{26,27} ✦ LC²⁷ ✦ Cholangitis³⁶ ✦ LFC^{37,38} ✦ Cholelith³⁴ ✦ Hepatocellular carcinoma⁴¹
Alkaline phosphatase‡ (ALP)	Membrane of hepatocytes, bone, intestine, kidney, placenta	Neonates (colostrum), young animals (bone growth), hyperthyroidism, inflammation and neoplasia, late pregnancy, lipidosis	6 h	Within 2 days of EHBDO	2–3 weeks after recovery	Cholestasis	<ul style="list-style-type: none"> ✦ Biliary cyst, cholecystitis and NC^{26,27} ✦ LC^{27–29} ✦ Choledochal cyst³⁰ ✦ EHBDO²² ✦ Gallbladder sludge²³ ✦ Cholelith^{12,32–34} ✦ Cholestasis¹² ✦ Non-specified hepatobiliary disease³⁵ ✦ Normal in most cases of NC with cholecystitis²⁶ ✦ Cholangitis³⁶ ✦ LFC^{37,38} ✦ Gallbladder mucocele and lipidosis³⁹
γ-glutamyltransferase (γGT)	Kidney, pancreas, intestine, gallbladder, membrane of cholangiocytes	–	–	Within 3 days of EHBDO	–	Cholestasis (interpret together with ALP)	<ul style="list-style-type: none"> ✦ Biliary cyst, cholecystitis and NC²⁷ ✦ LC²⁷ ✦ EHBDO²² ✦ Cholangitis³⁶ ✦ Cholecystitis, cholelith, gallbladder rupture and peritonitis⁴⁰

have consistently been seen after experimental ligation of the CBD, this finding is not encountered in clinical practice.¹²

Diagnosis

Increased activity of liver enzymes, especially the short-lived alkaline phosphatase, may indicate cholestasis (see Table 1).^{7,14} Elevations



Liver enzyme activity may be abnormally increased in liver disease, systemic diseases that influence the liver ('reactive hepatopathy'), and as a sequela to the administration of certain drugs.

in total bilirubin and bile acids are also commonly seen.^{7,12,23}

EHBDO can often be diagnosed with ultrasound. In normal cats, intrahepatic and extrahepatic ducts are not visible; thus, any duct visible on ultrasonography is considered dilated.²² The diameter of the CBD is a useful parameter in diagnosing EHBDO since it is greater than 5 mm in 97% of affected cats; the upper limit for healthy cats has been established at 4 mm.^{21,22}

In contrast, gallbladder dilatation is

Table 1 Continued from page 516

Parameter	Anatomical distribution	Increases in response to:	t _{1/2}	Increases observed:	Decreases observed:	Especially useful in:	Findings in biliary and gallbladder diseases (with supporting references)
Lactate dehydrogenase [§] (LDH)	Skeletal muscle, heart, kidney, intestine, cytosol of hepatocytes, lung, pancreas	Diffuse severe hepatic necrosis or inflammation; young animals (higher in kittens than adults)	-	-	-	-	-
Arginase	Cytosol of hepatocytes and mitochondria	-	-	-	-	-	-
Sorbitol dehydrogenase [§] (SDH)	Cytosol of hepatocytes	-	-	-	-	-	-
γ-globulins	-	-	-	-	-	-	<ul style="list-style-type: none"> ✦ LC²⁹ ✦ LFC (globulins unspecified)³⁷ ✦ Bile duct carcinoma⁴²
Bile acids	-	Loss of functional hepatic mass	-	-	-	-	<ul style="list-style-type: none"> ✦ Normal in EHBDO (preprandial)²⁴ ✦ Normal in cholecystitis⁷ ✦ Cholestasis⁷ ✦ Cholelith⁷ ✦ LFC⁷ ✦ EHBDO⁷ ✦ Normal in trauma of lower biliary tract⁷
Cholesterol	-	-	-	-	-	-	<ul style="list-style-type: none"> ✦ EHBDO²² ✦ Cholelith³⁴
Bilirubin	-	-	-	-	-	-	<ul style="list-style-type: none"> ✦ LC²⁷⁻²⁹ ✦ Choledochal cyst³⁰ ✦ EHBDO^{22,24} ✦ Gallbladder sludge²³ ✦ Gallbladder mucocele and lipidosis³⁹ ✦ Cholelith^{12,32,34} ✦ Avulsion of CBD¹² ✦ Cholestasis¹² ✦ Non-specified hepatobiliary disease³⁵ ✦ NC and cholecystitis²⁶ ✦ Cholangitis³⁶ ✦ LFC^{37,38} ✦ Cholecystitis, cholelith, gallbladder rupture and peritonitis⁴⁰

*Mostly periportal in location

†Mostly periacinar in location

‡Does not increase in cats treated with glucocorticoids

§Not used routinely

LC = lymphocytic cholangitis; AD-PKD = autosomal dominant polycystic kidney disease; EHBDO = extrahepatic bile duct obstruction; CBD = common bile duct; LFC = cholangitis due to liver flukes; NC = neutrophilic cholangitis; t_{1/2} = half-life in the circulation

not a reliable sign of EHBDO in clinical practice, although it is invariably seen after experimental bile duct ligation.²²

Treatment

Treatment depends on the cause of the obstruction, and may involve the use of cholagogues such as ursodeoxycholic acid (UDCA) (bile sludge), surgery (choleliths, foreign body, mucocele), praziquantel (liver flukes), prednisolone (cholangitis, gastrointestinal disease), antibiotics (suppurative cholangitis, gastrointestinal disease), and a low fat diet, antiemetics and supportive fluids (pancreatitis).

Prognosis

Many of the above-mentioned therapies can be very successful in relieving cholestasis, though the prognosis is heavily dependent on the underlying cause.

Inflammation of the biliary system

Inflammatory bile duct diseases are among the most common types of hepatopathy in cats.^{11,43} Feline cholangitis may be accompanied by pancreatitis, inflammatory bowel disease and cholecystitis.^{36,44}

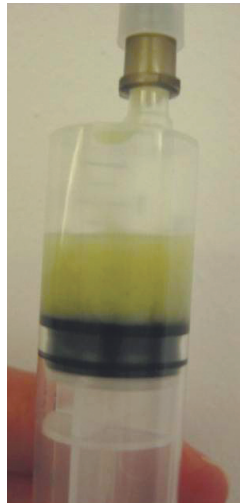


Figure 2 Bile sample from a cat with neutrophilic cholangitis. The bile is yellow and turbid due to the presence of pus

Neutrophilic cholangitis

Aetiology

Enteric bacteria have been implicated in inflammatory liver disease, with translocation across the mucosal barrier being the most likely source of infection.^{26,35,44} Neutrophilic cholangitis (NC) may also be caused by ascending bacterial infection from the gut or haematogenous dissemination of enteric bacteria.^{26,45,46} In healthy cats, transient bacterobilia exists although the biliary tract is considered to be sterile.⁴⁷

In cats, NC is accompanied by cholecystitis.²⁶ In fact, these are likely not distinct entities in cats.

Clinical signs

The most prominent clinical signs of NC are nausea, vomiting, anorexia and fever. Icterus is present in a minority of cases.

Diagnosis

Examination of a sample of bile is the most likely route to a diagnosis (Figure 2).^{26,48} Bile samples can be obtained by cholecystocentesis with a 22 G needle under ultrasound guidance (see box below). Ultrasonography usually reveals no abnormalities of the gallbladder,

Biopsy and cholecystocentesis

Histopathology is the gold standard for diagnosing hepatobiliary diseases.¹¹ Ultrasound may aid in establishing a diagnosis in cystic diseases, cholestasis, neutrophilic cholangitis (NC), lymphocytic cholangitis (LC), cholangitis due to liver flukes, and gallbladder mucocele. Bile cytology and/or culture may be helpful in NC and LC.¹¹

Liver biopsy techniques

Liver tissue can be sampled during open or laparoscopic surgery or with the aid of a large bore needle.⁴⁹ Different techniques yield different amounts of tissue: laparoscopic cup biopsy forceps yield around 45 mg, a 14 G Tru-Cut-type biopsy needle around 15–20 mg, and an 18 G biopsy needle around 3–5 mg. At least two or three biopsies from separate liver lobes should be obtained. A 16 G needle is preferred and five to six portal areas should be present in order to establish a good histopathological diagnosis.⁵⁰

Recommendations and precautions for liver biopsy include:

- ❖ Fast the patient for 12 h so that the stomach is empty.
- ❖ Perform coagulation tests to ensure there is no bleeding disorder.
- ❖ Do not take a liver biopsy when fibrinogen concentrations are lower than 50% of the lower reference interval.
- ❖ In prolonged and severe EHBDO, administer vitamin K1 before taking a biopsy (1–5 mg/kg q24h SC for several days).
- ❖ Do not use an automatic spring-loaded biopsy gun in cats;⁵¹ this may lead to lethal shock reactions, especially in non-anesthetised cats!
- ❖ The manual Menghini technique can be used in cats.
- ❖ Take laparoscopic liver biopsies early on in surgery, as hepatocellular changes may result from prolonged anaesthesia, vascular changes and handling of the intestines.

Note that neoplastic masses may have necrotic centres, which makes it best to sample from the periphery of the lesion. Diffuse liver disease, including neoplasia, may be sampled with fine-needle aspiration (FNA).

Fine-needle aspiration

Ultrasound may help in determining the exact location for FNA. A blind technique may also be used – appropriate locations include caudal to the costal arch or on the right side at the 10th intercostal space at the level of the rib–cartilage junction. There is no need for local or general anaesthesia and 3 inch disposable 20–22 G needles are recommended.

Percutaneous ultrasound-guided cholecystocentesis⁴⁶

Percutaneous ultrasound-guided cholecystocentesis (PUC) is a minimally invasive technique for obtaining a sample of bile (0.9–3 ml). A 22 G 1.5 inch needle connected to a 12 ml syringe has been used successfully. Ultrasound assists in guiding the needle into the gallbladder.⁴⁹ To help prevent leakage of gallbladder contents into the abdomen, the aim should be to completely empty the gallbladder and confirm this with ultrasound. Bile in the peritoneal cavity causes a chemical peritonitis and predisposes the cat to bacterial infection.⁷ PUC could cause leakage if there is complete obstruction of the CBD and should be avoided in cases where EHBDO is likely.

although oedema of the gallbladder wall may be seen in acute, severe cases. Cytology of bile will reveal neutrophils and sometimes bacteria. Culture will determine the bacterial species present, and their antimicrobial susceptibility. A biochemical profile is often within normal limits or may show increased activity of alanine aminotransferase, while the most common finding on a complete blood count is leukocytosis.

Table 2 Reported use of medical therapies for feline biliary disease

Disease	Therapy
NC ²⁷	Metronidazole 30 mg/kg q24h PO and amoxicillin 10 mg/kg q12h PO for 2 months
NC ^{26,28}	Amoxicillin/clavulanate 45 mg q12h SC initially, then 50 mg PO q12h for 4 weeks in total (cat body weight 2.85 kg), or ticarcillin/clavulanate PO for at least 4 weeks
NC ²⁶	UDCA 50 mg q24h PO and vitamin K1 6 mg q24h PO
NC and cholecystitis ²⁶	Enrofloxacin 2.5 mg/kg q12h SC
NC and cholecystitis ²⁶	Amoxicillin/clavulanate 100 mg q8h IV, ciprofloxacin 30 mg q24h PO and UDCA 30 mg q24h PO (cat body weight 2.3 kg) for 2 weeks
NC and cholecystitis ²⁶	Amoxicillin 70 mg q12h SC
NC and cholecystitis ²⁶	Doxycycline 50 mg q12h PO and cephalexin IV for 7 days, then 112.5 mg q12h PO for 4 weeks in total
Cholecystitis ⁵²	NSAIDs
Cholecystitis ^{7,35}	Chloramphenicol Fluoroquinolones Amoxicillin/clavulanate Metronidazole
Gallbladder rupture, NC and cholecystitis ²⁶	Cefoxitin 120 mg q8h IM and amoxicillin 100 mg q12h PO
Choledochal cyst ³⁰	<i>Pre-surgery</i> (and continued for 3 days): amoxicillin/clavulanate 60 mg q8h IV and metronidazole 30 mg q12h IV <i>Post-surgery</i> : amoxicillin/clavulanate 50 mg q12h PO, metronidazole 33.3 mg q12h PO, UDCA 37.5 mg q24h PO, S-adenosylmethionine 50 mg q24h PO, vitamin E 10 mg q24h PO and vitamin K 0.05 mg q24h PO
EHBDO ²⁴	4 week course of potentiated amoxicillin 15 mg/kg q12h PO, metronidazole 15 mg/kg q24h PO, and Samylin* 1 g sachet q24h PO
LC ⁵³	Prednisolone 1–2 mg/kg q24h PO for 4–6 weeks, followed by gradual dose tapering
LC, ⁵³ mucocele, choleliths, cholestasis ^{18,39}	UDCA 15 mg/kg q24h PO
LC ²⁹	Prednisolone (up to 4 mg/kg PO) for an initial period of 3 weeks, followed by gradual dose tapering over 6–8 weeks
EHBDO ³²	Amoxicillin/clavulanate 20 mg/kg q8h IV, metronidazole 10 mg/kg q12h IV, buprenorphine 30 mg/kg q8h IM, and vitamin K1 0.5 mg/kg q12h SC (for 3 days); followed by cephalexin 15 mg/kg q12h PO, metronidazole 10 mg/kg q12h PO and UDCA 10 mg/kg PO q24h (antibiotics for a total duration of 4 weeks)
Lipidosis ³⁹	Metaclopramide 0.05 mg/kg/h IV and ranitidine 1.5 mg/kg q12h IV
Hepatic encephalopathy ³⁹	Lactulose 1 ml q8h PO

*S-adenosyl L-methionine/silybin/vitamin E liver supplement (VetPlus)
NC = neutrophilic cholangitis; UDCA = ursodeoxycholic acid; EHBDO = extrahepatic bile duct obstruction; LC = lymphocytic cholangitis; NSAIDs = non-steroidal anti-inflammatory drugs; PO = orally; IV = intravenously; SC = subcutaneously; IM = intramuscularly

Treatment

Amoxicillin/clavulanate and ticarcillin/clavulanate for at least 4 weeks have been used successfully in the treatment of NC,^{26,28} and are the first-choice treatment (Table 2). Other antibiotics, such as chloramphenicol, fluoroquinolones and metronidazole, are well excreted in bile, have good anaerobic activity and may be considered.^{7,35} It is recommended that susceptibility testing is performed routinely to allow selection of the best antibiotic. Long-term treatment is essential to prevent recurrence.

Increased levels of cyclooxygenase were detected in inflamed mucosa of feline gallbladders in one experimental study,⁵⁴ suggesting a role for non-steroidal anti-inflammatory drugs (NSAIDs) in the treatment of cholecystitis.⁵²

Adjunctive therapies used for NC have included UDCA and vitamin K.²⁶ However, there is no evidence for their beneficial effect and, in the authors' opinion, treatments for NC should be limited to long-term use of antibiotics, as discussed above.⁵⁵

Prognosis

The only study that reports on prognosis for feline NC states that most cats regained their previous health after receiving the appropriate antibiotics.²⁶ However, if treatment is too late or unsuccessful the disease is often fatal.³⁶

Lymphocytic cholangitis

Aetiology

Bacterial as well as immunological aetiologies have been suggested for lymphocytic cholangitis (LC).^{29,56–60} Hypothetically, an infectious agent could initiate inflammation, which could then be sustained as an immune-mediated disease after the infectious agent has been eliminated. This would suggest that LC could be a chronic sequela to NC. However, no such connection has ever been confirmed. LC and NC are presently considered to be two separate, unconnected diseases. Additionally, LC has been diagnosed secondarily to bile duct obstruction by choleliths.³² To date, however, no definite aetiology has been established.

Clinical signs

Nausea, chronic vomiting, diarrhoea, anorexia and icterus are seen in LC, as are polyphagia and weight loss.^{27,30} The course of the disease is often protracted, spanning months to years. Icterus, if present, usually indicates advanced disease. Male cats appear to be affected more frequently than females.⁵³

Diagnosis

Hypergammaglobulinaemia is the most consistent abnormality on the biochemical

profile.^{28,29} This, together with the chronicity of the disease, often leads to a misdiagnosis of FIP.⁶¹ Ultrasonographically, dilated intra- and extrahepatic bile ducts are frequently seen (Figure 3), although not all cases of LC have ultrasonographic changes in the bile ducts. Dilatation of the bile ducts excludes FIP. It is not possible to distinguish between NC and LC based on these findings.³⁶ Furthermore, ultrasound has limited sensitivity for detecting infiltrative liver diseases.²²

FNA is not diagnostic. Cytology may show lymphocytes and may lead to a misdiagnosis of malignant lymphoma.^{62–65} The portal distribution of lesions in cats with LC cannot be identified with FNA cytology and there is a

Lymphocytic cholangitis is often misdiagnosed as FIP, on the basis of disease chronicity and hypergammaglobulinaemia on the biochemical profile.



Figure 3 Distended bile ducts in a cat. GB = gallbladder; BD = bile duct. Reproduced from the WSAVA Standards for Clinical and Histological Diagnosis of Canine and Feline Liver Diseases,¹¹ with permission of Dr George Voorhout

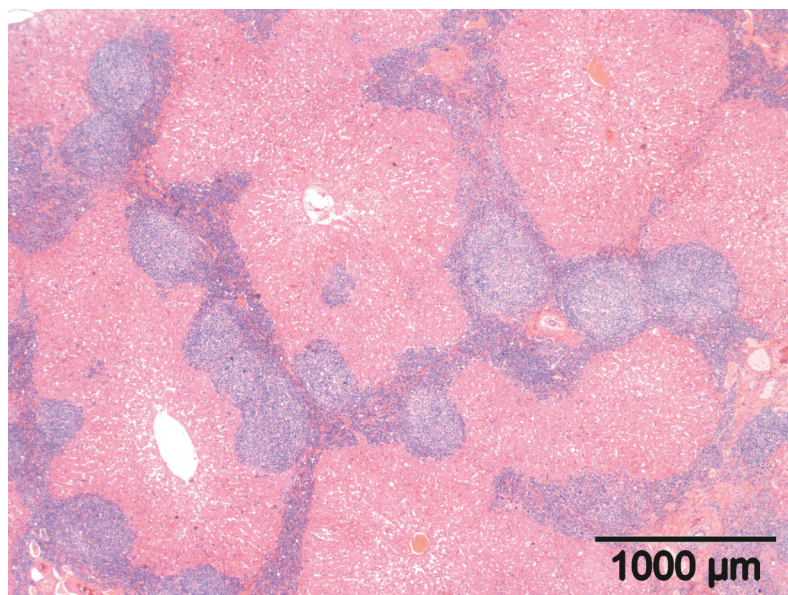
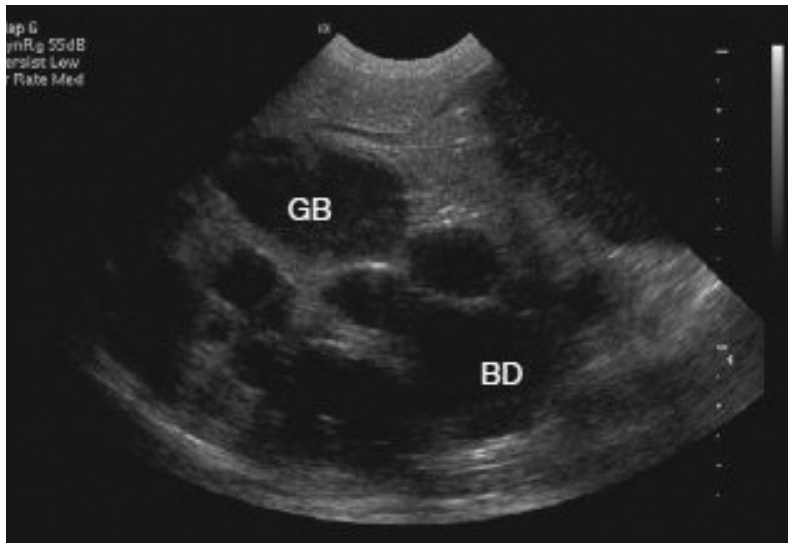


Figure 4 Histology of a liver biopsy sample from a cat with lymphocytic cholangitis. Dense infiltrates of small lymphocytes are present in portal areas, extending to portal-portal bridging. Haematoxylin and eosin

discrepancy between histology and cytology in 55% of cases.^{66,67}

Histology is the gold standard for diagnosing LC (Figure 4). Either surgical or laparoscopic wedge biopsy procedures may be used, or alternatively larger needle biopsy techniques (see box on page 518) that obtain at least five portal triads – the sample size that is considered representative in humans.⁵⁰ In a study comparing needle and wedge biopsies, only 2/13 cats and dogs received the same histological diagnosis;⁵⁰ this is likely due to the small needle diameter used for liver sampling. In the authors' experience, the diagnosis of LC can be accurately made with Tru-Cut liver biopsies of sufficient size. This is achieved using a 16 G needle in a semi-automatic biopsy gun (see box on page 518). Thinner needles lead to diagnostic inaccuracy; surgical wedge biopsies should be pursued in preference.

Typical histological lesions are lymphocytic inflammation of the biliary tree with fibrosis surrounding the bile ducts (an expression of the chronicity of the process). Lymphocytes are present inside the lumen and wall, and around the bile ducts in the portal triads. In cats with LC, the biliary system is prone to infection, leading to a mixed lymphocytic and neutrophilic inflammation.

Treatment

Corticosteroids, such as prednisolone (1–2 mg/kg q24h), and UDCA (15 mg/kg q24h) have been used as treatments for LC.^{29,53,60} If there is secondary bacterial infection, treatment should also include appropriate antibiotics for 4–5 weeks. The best sample for cytological identification of bacteria and culture for sensitivity testing is bile, obtained by ultrasound-guided aspiration of the gallbladder.

Prognosis

Data from 23 cats showed that 70% survived for more than 1 year, with a mean survival time of 51.8 months.⁴³ In a separate study, cats treated with prednisolone had better survival rates than cats treated with UDCA; overall survival rates for 1, 2 and 3 years were 74%, 56% and 35%, respectively, with a median overall survival of 795 days (~26 months).⁵³



Figure 5 Cholangitis due to liver fluke infection. Reprinted with permission from the WSAVA Standards for Clinical and Histological Diagnosis of Canine and Feline Liver Diseases.¹¹ Image courtesy of the Society of Comparative Hepatology

Cholangitis due to liver flukes

Aetiology

Liver flukes that cause feline cholangitis are members of the Opisthorchiidae or Dicrocoeliidae families; *Platynosomum* species are most common in (sub)tropical regions.^{11,37,68} Snails and lizards carry the liver fluke and cats become infected when they ingest these prey items.^{11,68} Adult flukes reside in the bile ducts and gallbladder of affected animals, and this may lead to cholestasis (Figure 5).^{7,68}

Clinical signs

Cats with cholangitis due to liver flukes (LFC) show clinical signs such as lethargy, weight loss, decreased appetite, abdominal pain and vomiting.^{37,38} Icterus may be observed and is associated with cholestasis due to high numbers of parasites.⁶⁸

Diagnosis

Microscopic examination of liver biopsies, bile or faeces may sometimes reveal liver fluke eggs.^{38,69} Eosinophilic inflammation in the portal areas on liver histology is suggestive of LFC.³⁸ Chronic LFC leads to dilatation and fibrosis of bile ducts, which can be seen on ultrasound.⁶⁸ These imaging findings are very similar to those of chronic LC. A blood smear or complete blood count sometimes reveals eosinophilia, which is never seen in cats with LC.

Treatment

Liver flukes can be treated adequately with praziquantel (20 mg/kg q24h PO for 3 days).³⁷

Prognosis

With the correct therapy the prognosis is excellent.⁷⁰ Changes to the biliary tree, such as dilatations, will persist and will increase

the patient's sensitivity to ascending bacterial infections from the intestines.²⁸

Cholecystitis

Aetiology

Experimentally, feline cholecystitis has been induced by platelet activating factor, *Escherichia coli* lipopolysaccharide and xenotransplantation of human gallstones into feline gallbladders.^{52,54} Furthermore, cytolytic agents in bile cause severe inflammation in cholestasis,²⁷ and bile salts cause tissue necrosis, aiding in bacterial colonisation.⁷ These bacteria may either be blood-borne or originate from the intestines.^{7,44} In cats, cholecystitis may be accompanied by NC.²⁶ Bile peritonitis has never been reported as a sequela to cholecystitis in cats.⁷¹

As discussed, there are no indications that cholecystitis and NC are distinctly different entities in the cat.

Clinical signs

Reported clinical signs include inappetence, lethargy, vomiting, anorexia, diarrhoea, jaundice, cranial abdominal pain, weight loss, pyrexia, anaemia and mild hyperbilirubinaemia.^{26,40}

Diagnosis

Ultrasound may demonstrate a thick, double-walled, oedematous gallbladder wall in acute forms of cholecystitis, and a thinner, single-layered wall in chronic or mild inflammation.⁷² In one study of six cats, cholecystocentesis yielded bacteria (*E coli*, *Streptococcus* species, *Clostridium* species and *Salmonella enterica*), as well as degenerate inflammatory cells in most cases.²⁶ Histology of the gallbladder wall shows neutrophils in the epithelium and/or wall.¹¹

Treatment

Increased levels of cyclooxygenase have been detected in inflamed mucosa of feline gallbladders,⁵⁴ suggesting a role for NSAIDs in the treatment of cholecystitis.⁵² Antibiotics such as chloramphenicol, fluoroquinolones, amoxicillin/clavulanate and metronidazole concentrate in bile and have good anaerobic activity.^{7,35}

Prognosis

Based on the only published study, the prognosis is good when the right antibiotic has been determined and administered.²⁶



The prognosis for cholecystitis appears to be good when the right antibiotic has been determined and administered.

Accessory gallbladder

An accessory gallbladder is a relatively common anatomical variant in cats, and this can be readily explained by the embryological development of the feline gallbladder.¹⁷ The partially subdivided gallbladder (*vesica fellea divisa*) is most commonly seen, although a double biliary vesicle (*vesica fellea duplex* or true duplex gallbladder) with two cystic ducts has been described in 10% of cases.^{17,18} Some feline gallbladders again subdivide, leading to a pseudo-multiplex form (*vesica fellea multiplex*).¹⁷

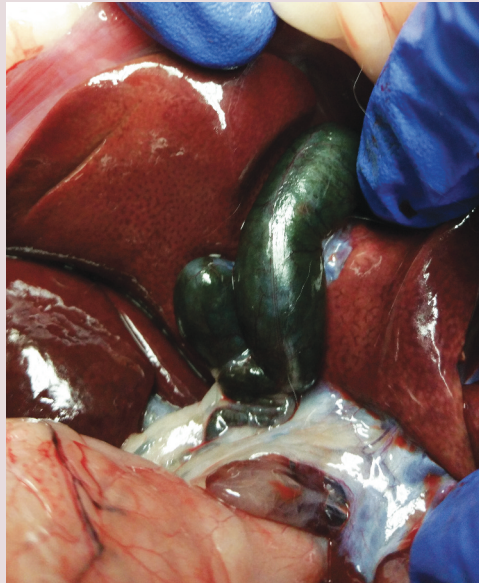


Figure 6 Accessory gallbladder, an incidental finding at necropsy

Accessory gallbladders are mostly incidental findings, and cause no clinical signs.



Diseases of the gallbladder

Anomalies in gallbladder shape are frequently seen on ultrasound examination and over 12% of cats have some form of accessory gallbladder (see box above).^{17,72} Most of the diagnosed aberrant gallbladders are incidental findings during ultrasound examination, surgery or at necropsy (Figure 6) and cause no clinical signs. Cholecystectomy can be performed if removal of the aberrant gallbladder is necessary.

Cholelithiasis

Aetiology

Choleliths (gallstones) are encountered infrequently, accounting for fewer than 1% of canine and feline cases of liver disease combined.⁷ They are much more common in humans. The majority of human gallstones are predominantly comprised of cholesterol, with pigment stones being much rarer.³³ Based on what is known about the pathogenesis of choleliths in man and prairie dogs, a number of contributing factors can be proposed (see right).

Choleliths are sometimes encountered in cases of EHBDO.²² They consist of calcium carbonate or palmitate, and amorphous plugs of bile salts and cholesterol.²² Other studies have identified stones composed of a combination of: bilirubin,³² calcium carbonate, oxalate, phosphate and magne-

sium;^{12,40} calcium carbonate and calcium bilirubinate;^{27,33} cholesterol, bilirubin derivatives and calcium salts;⁷ and calcium carbonate, calcium bilirubinate and cholesterol.³⁴ Based on their composition, most feline stones are classified as black (bilirubin) or brown (bacterial degradation of biliary matter), also known as pigment gallstones.⁷⁴

Altered gallbladder motility, mucin hypersecretion and ascending bacterial infection might have contributed to stone formation in a case reported by Elwood and colleagues.³³

No definitive causal relationship has been determined between the presence of gallbladder sludge and the formation of stones.²³

Clinical signs

Symptomatic cholelithiasis is not encountered frequently in the cat,⁷ and clinical signs might be associated with the cause or consequence of cholelithiasis rather than the choleliths themselves.³³ Vomiting has been reported, as well as dehydration, anorexia, icterus and lethargy.^{27,32,34} Interestingly, most cats with choleliths are male.³⁴

Diagnosis

Bile can be examined cytologically for cells, crystals and bacteria.³³ Radiographs, ultrasound and cholecystography with contrast can be used to visualise gallstones.^{7,33,34}

Treatment

Litholytic and cholcretic agents, such as UDCA, are used in treating asymptomatic cholesterol

Cholelithiasis: potential contributing factors^{27,32,34,73,74}

- ❖ Bile supersaturation
- ❖ Precipitation of a nucleus (nidi)
- ❖ Mucin hypersecretion
- ❖ Aberrant pH of bile
- ❖ Biliary stasis or aberrant gallbladder motility
- ❖ Altered bile composition
- ❖ Cholecystitis
- ❖ Cholangitis
- ❖ Dietary factors
- ❖ Biliary bacterial infections
- ❖ Haemolysis

Techniques employed in biliary surgery in cats¹²

When surgery is necessary – to establish a diagnosis, to prevent leakage of bile or to repair bile flow from the gallbladder to the intestines – several techniques have been used successfully in cats, as listed below.

- ❖ Cholecystoduodenostomy
- ❖ Cholecystojejunostomy
- ❖ Choledochojejunostomy
- ❖ Choledochotomy, with or without tube stenting
- ❖ Duodenotomy with CBD lavage or cholecystotomy
- ❖ Tube cholecystostomy
- ❖ Primary gallbladder repair
- ❖ Cholecystectomy

Method of choice

Cholecystoenterostomy is the method of choice due to the small diameter of the feline CBD. Vomiting and anorexia are commonly seen after biliary surgery; therefore, it is advisable to place a feeding tube while the cat is under anaesthesia. As cholecystoenterostomy creates an open connection between the enteric lumen and the bile and pancreatic ducts, an inevitable complication is infection of the bile ducts and pancreas, necessitating repeated antibiotic treatment. This procedure often does not lead to significant improvement or prolongation of life expectancy.

It is advisable to place a feeding tube while the cat is under anaesthesia for biliary surgery.



gallstones in humans. UDCA has been used safely in cats at a dosage of 15 mg/kg body weight q24h PO.⁵³ In contrast, pigment stones in humans are removed surgically; surgical removal of the gallbladder has been shown to prevent recurrence of stone formation.^{33,73} In cats, surgery has been used successfully to remove stones or the gallbladder itself, as well as to divert the biliary tract (see box above for commonly used surgical techniques).^{22,32–34}

Prognosis

The prognosis is guarded since choleliths may be the cause or the consequence of disease. The underlying or resultant disease will ultimately determine the outcome. When cats survive surgery and recuperate well, the prognosis can be favourable.

Gallbladder mucocele

Aetiology

Mucous glands in the epithelium of the gallbladder protect against the deleterious effects of bile acids. Cats have fewer mucous glands than dogs, which may explain why mucoceles have been reported less frequently in cats than in dogs.⁷² In total, three feline cases have been described.^{18,22,39} In dogs, mucoceles have a distinct striated pattern, but no such pattern was reported for the three cats.¹¹ Mucous gland hyperplasia was described in one feline case.⁷²

In a case report by Bennett and colleagues, concurrent hepatic lipidosis was diagnosed.³⁹ Dyslipidaemias, possibly induced by excessive glucocorticoid use, have been implicated in the formation of canine gallbladder mucoceles.⁷⁵ Certain breeds (Shetland Sheepdog), gene mutations and endocrinopathies (hypothyroidism and hypercortisolism) have been associated with canine gallbladder mucoceles.^{75,76}

Clinical signs

Reported clinical signs have included vomiting, anorexia, lethargy, weight loss and icterus.^{18,39} Conceivably, these could have been associated with concurrent diseases, such as EHBDO, hepatic lipidosis and cholestasis, and not with the mucocele per se.

Diagnosis

Gallbladder mucoceles can be seen with abdominal ultrasound. Cholecystocentesis usually does not yield any fluid because of the thick, inspissated bile.³⁹ Histology of the gallbladder wall would show cystic mucinous hyperplasia.^{11,39}

Treatment

Surgical removal of the gallbladder was described by Woods et al.¹⁸ Other treatment approaches have included cholecystojejunostomy,³⁹ and the use of choleric drugs such as UDCA.¹⁸ The prevailing opinion is that, for dogs, cholecystectomy is the most effective treatment.⁷⁷

Prognosis

Two of the three cats reported in the literature did well.^{18,39} Possible complications include rupture of the gallbladder and recurrence. The prognosis is guarded in cases of feline EHBDO and hepatic lipidosis. High mortality rates have been reported with biliary diversion surgery in cats.¹²

Gallbladder infarctions

Aetiology

Thrombosis of the cystic artery, a branch of the hepatic artery and the sole arterial blood supply to the gallbladder, may cause gallbladder infarcts.¹¹ Theoretically, torsion of the gallbladder may also cause arterial occlusion and infarction. The fundus of the gallbladder has

been specified as being the site most prone to rupture as a sequela to ischaemia.⁷¹ While necrotic areas and ischaemia have been observed in the gallbladders of cats, the authors of that study linked these findings to anaerobic bacterial infection.²⁶ Gallbladder infarcts have been described in a series of dogs, but not in cats.⁷⁸

The bile peritonitis that is expected to follow gallbladder infarction and necrosis is rarely encountered in feline practice, and was reported only once (0.3%) in 396 cases studied.⁷⁹ This might be due to the biliary epithelium exhibiting excellent regenerative properties, as has been recognised in dogs.³⁹

Clinical signs

Clinical signs (in dogs) have included vomiting, icterus, anorexia, pyrexia and diarrhoea.⁷⁸ Bile peritonitis in two cats was associated with anorexia and vomiting.⁷¹

Diagnosis

Ultrasound can help in identifying abnormalities in the gallbladder, as well as in showing poor abdominal detail suggestive of abdominal effusion.^{71,78} In a review of 12 canine cases, surgery confirmed ruptured and distended gallbladders, but no torsions were encountered.⁷⁸ Histology of the gallbladder wall shows necrosis and thrombosis of the artery.¹¹

Cytology of abdominal effusion in bile peritonitis has revealed predominantly neutrophils and macrophages, with golden to greenish-brown material in the cytoplasm of macrophages or in the background.⁷⁹ Bile leakage was shown to be diagnosed effectively by a greater than two-fold increase in the bilirubin concentration of the effusion compared with serum.⁷¹

Treatment

Damaged gallbladders must be surgically removed and trauma causing bile peritonitis must be surgically repaired. Supportive therapies, such as fluid therapy and assisted feeding, might be required to assure the patient's recovery.

Prognosis

Conjecturing from the scant information available, a guarded prognosis is anticipated. Thrombosis might be caused by vascular problems, which may have a far greater impact on the cat than gallbladder infarction. Biliary disease in cats is associated with nausea, vomiting and anorexia, which predisposes the patient to hepatic lipidosis. Bile salts are toxic to tissues, leading to tissue necrosis and the growth of bacteria.⁷ A further consideration is that biliary diversion surgery has been shown to be associated with high mortality rates.^{12,80}

Neoplasia

Aetiology

In cats, neoplasms of the biliary system occur more frequently than neoplasms of hepatic cell origin.⁸¹ A brief summary of primary tumour types that have been identified is given in the box on the left.

Cholangitis was present concurrently in 3/25 cats suffering from cholangiocellular tumours, while another three cats had concurrent autosomal dominant polycystic kidney disease (AD-PKD).⁸³ It has been proposed that cholangitis may be involved in the aetiology of cholangiocellular feline tumours.⁸³

Bile duct adenomas have been found to be associated with bile duct adenocarcinomas, suggesting that adenoma, metaplasia and dysplasia may be viewed as precursor lesions in cats.⁸¹ This same study found no choleliths in

the cats with either gallbladder carcinoma or bile duct adenocarcinomas.⁸¹

Lymphoma and mast cell tumours were most frequently found as concurrent neoplasms, although lymphoma of the gallbladder is extremely rare.^{65,81} There is a single case report of urinary bladder lymphoma associated with concurrent involvement of the gallbladder.⁸⁴ Feline neuroendocrine epithelial tumours have been reported, possibly the result of a malignant transformation of hepatic stem cells.^{81,82}

Clinical signs

Male cats are overrepresented for biliary adenocarcinomas and cystadenocarcinomas, with up to 38% of cats being asymptomatic.⁸² In symptomatic cases, clinical signs are similar to those seen in other hepatobiliary disorders, and include icterus.⁸² Paraneoplastic alopecia has been reported in two cats with hepatocellular carcinoma and bile duct carcinoma.^{41,42}

Diagnosis

Severe thickening of the gallbladder wall or CBD has been observed on ultrasound.^{22,84} Radiography, cytology and tissue biopsy may all be helpful in identifying neoplastic lesions.⁸²

Treatment

A large part of the liver can be surgically resected without impairing hepatic function, so surgical removal of focal lesions seems to be the best option. Systemic chemotherapy is relatively ineffective.^{82,85}

Hepatobiliary tumour types

In an overview of primary hepatic and biliary tract tumours by Wypij and colleagues, bile duct tumours were classified as (cyst)adenoma or adenocarcinoma, and gallbladder tumours were either adenomas or adenocarcinomas.⁸² An ultrasonographic study identified EHBDO associated with neoplasia of biliary origin; tumour types found were carcinoma of the biliary tract and unclassified pancreatic/biliary tract carcinoma.²² In another study, 41% of hepatic tumours examined histologically and immunohistochemically were cholangiocellular tumours,⁸³ although primary liver tumours account for only 1.0–5.5% of all tumours in cats.^{82,83}

In cats,
neoplasms
of the biliary
system occur
more
frequently than
neoplasms of
hepatic cell
origin.



Prognosis

Up to 65% of primary hepatobiliary tumours in cats are reported to be benign.⁸² However, malignant biliary tumours have been found to have higher metastatic rates than hepatocellular carcinomas.⁸¹

Cystic diseases

Cysts in the liver (Figure 7) always arise from the bile system, and are therefore also considered a biliary disease.

Solitary biliary cysts

Case reports have documented biliary cysts in cougars, lions and leopards, as well as in domestic cats.^{27,30,86,87}

Aetiology

Extrahepatic solitary cysts of the biliary system are found occasionally in cats.³⁰ To the authors' knowledge, no aetiology has been suggested.

In humans, where the condition is also encountered, several aetiological mechanisms have been proposed:⁸⁸

- ❖ Differences in epithelial cell proliferation, causing the area with faster proliferation rates to distend;
- ❖ Reflux of pancreatic enzymes into the cystic duct due to a defect in the pancreaticobiliary sphincter;
- ❖ Localised weakness in the wall of the biliary duct.

Experimentally, biliary cysts have been created in puppies, but not in adult dogs, by scraping the mucosa of the bile duct followed by CBD ligation.⁸⁸

Biliary cystadenomas, an uncommon benign liver tumour of older cats, may be encountered as a focal or multifocal cystic lesion.⁸⁹ While the tissue of origin is still unknown, the cysts are speculated to arise from 'small retention cysts associated with embryologic bile ducts that do not connect to the main biliary tree'.⁸⁹

Clinical signs

Clinical signs in a domestic shorthair cat with a cyst arising from the CBD included polyphagia, weight loss, nervousness, and urinating in the house due to increased pressure on the bladder by the cyst.³⁰ Chronic vomiting and anorexia were reported in another case, although this cat also suffered from suppurative cholangitis which could have caused these clinical signs.²⁷

Hepatobiliary cysts have been found as intrapericardial lesions following diaphragmatic herniation, and were the cause of progressive exercise intolerance and coughing.⁸⁷

Biliary cystadenomas were reported to be associated with anorexia, lethargy, weight loss, occasional vomiting and weakness, but no abdominal pain or discomfort.⁸⁹

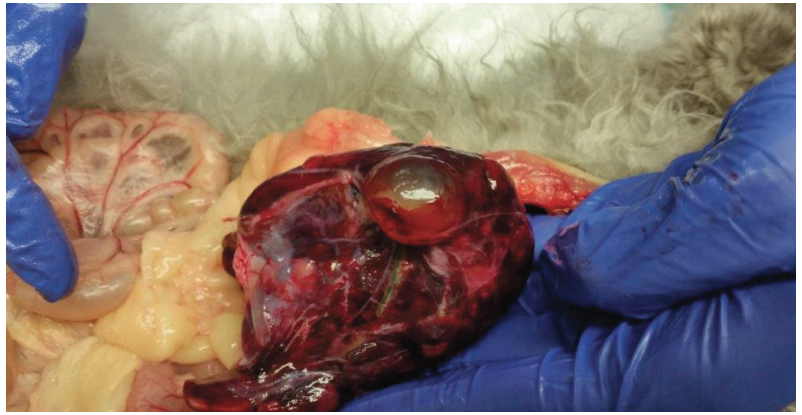


Figure 7 Liver cyst, an incidental finding at necropsy. Courtesy of Marleen Assink

Diagnosis

Large cysts have been found during clinical examination.^{30,89} Diagnostic imaging might be helpful in locating biliary cysts, and some are found at necropsy (Figure 8).^{86,89} Clinical laboratory data may be normal, but elevations in liver enzymes (eg, alanine aminotransferase and alkaline phosphatase) and bilirubin have been reported.^{30,89} Clotting times were found to be within normal reference intervals,³⁰ and fluid analysis revealed high protein content and limited mixed bacterial growth.³⁰ True cysts usually contain bile.^{27,89}

Treatment

Complete or partial surgical resection is the treatment of choice when the cyst needs to be removed because of mechanical compression on adjacent structures.^{30,89}

Prognosis

The prognosis for cats with biliary cystadenomas is good, due to the benign nature of these cysts.⁸⁹ However, as the cause of solitary biliary cysts is usually unknown, recurrence might occur and the long-term outcome is uncertain.³⁰



Figure 8 Biliary cyst. Reprinted with permission from the WSAVA Standards for Clinical and Histological Diagnosis of Canine and Feline Liver Diseases.¹¹ Image courtesy of the Society of Comparative Hepatology

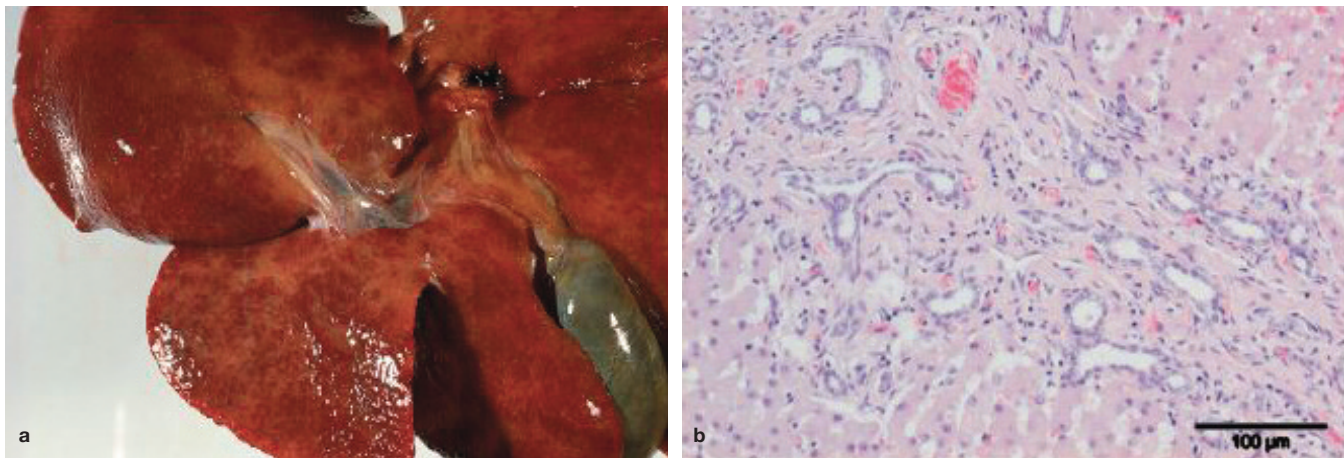


Figure 9 Juvenile biliary cystic disease with hepatic fibrosis – (a) macroscopy, (b) microscopy. Reprinted with permission from the WSAVA Standards for Clinical and Histological Diagnosis of Canine and Feline Liver Diseases.¹¹ Images courtesy of the Society of Comparative Hepatology

Congenital biliary cystic disease

Aetiology

Feline cystic liver disease is most often multifocal and has been found in 68% of cats with polycystic kidney disease (PKD).^{30,31} Persian cats inherit PKD as an autosomal dominant trait. Besides hepatic cysts, liver

fibrosis is also commonly seen in cats with PKD (Figure 9).³¹

Increased epithelial proliferation is involved in the formation of renal cysts in Persian cats. This occurs intermittently and in the early stages of cyst formation.⁹⁰

Clinical signs

PKD in Persian cats is clinically similar to human AD-PKD.^{11,90} Clinical signs are mostly a result of the renal disease, and not the hepatic cysts.

Diagnosis

Both renal and hepatic cysts may be visualised ultrasonographically. Hepatic lesions comprising cystic malformation and fibrosis are identified on liver histology.

Treatment

There is no treatment for PKD. Breeding programmes and genetic screening have contributed to a reduction in the number of affected cats over the years.

Prognosis

The prognosis for PKD is fair, since most cats only start showing clinical signs at an advanced age.

Conflict of interest

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KEY POINTS

- ❖ Biliary disease is more common in cats than disease of the hepatic parenchyma.
- ❖ Due to limited capacity for glucuronide conjugation of drugs and toxins, cats are prone to hepatotoxic injury. A number of frequently used veterinary drugs can be toxic to cats.
- ❖ Enteric bacteria have been implicated in inflammatory liver disease.
- ❖ Changes to the biliary tree, such as dilatations, will persist and will increase the patient's sensitivity to ascending bacterial infection from the intestines.
- ❖ One in eight cats have some form of accessory gallbladder. Usually, there are no clinical signs and these anomalies are found incidentally on ultrasound examination or at necropsy.
- ❖ Most cats with choleliths, lymphocytic cholangitis and neoplasia are male.
- ❖ The gallbladder has only a single artery supplying blood, but infarcts have never been described in cats.
- ❖ Biliary cysts are encountered in many felids, not just domestic cats. In domestic cats, liver cysts are linked to polycystic kidney disease.
- ❖ Histology, cytology and culture are valuable diagnostic tools in feline biliary disease.



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