Long-term survival and risk factors associated with biliary surgery in dogs: 34 cases (1994–2004)

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Objective—To determine factors associated with long-term survival after biliary surgery in dogs.

Design—Retrospective case series.

Animals—34 dogs that underwent biliary surgery.

Procedures—Data extracted from medical records included sex, breed, body weight, age at surgery, history and clinical examination findings, preoperative and postoperative CBC, serum biochemical panel and coagulation profiles results, abdominal ultrasonographic findings, results of bacteriologic culture and histologic examination, surgical findings, postoperative complications, and survival time. Follow-up information was obtained from medical records or phone conversations with owners and referring veterinarians.

Results—Primary biliary findings included gallbladder mucocele (n = 20 dogs), inflammatory diseases (4), trauma (3), and neoplasia (1). Secondary biliary diseases included pancreatitis (n = 4), pancreatic neoplasia (1), and duodenal perforation (1). One- and 2-year survival rates were both 66%. Increasing age; γ-glutamyltransferase activity; preanesthetic heart rate; BUN, phosphorus, and bilirubin concentrations; and the use of biliary diversion procedures were risk factors for death, although pancreatitis was not. However, poor long-term survival was associated with pancreatitis.

Conclusions and Clinical Relevance—Long-term prognosis was guarded after biliary surgery in dogs. However, dogs that survived the early postoperative period had good long-term prognosis. Dogs with pancreatitis had poor prognosis. Overall, the prognosis was worse for dogs that underwent a biliary diversion, compared with dogs that did not. (*J Am Vet Med Assoc* 2006;229:1451–1457)

Indications for biliary surgery in dogs include neoplasia of the bile duct, obstructive choleliths, inflammatory biliary tract diseases, rupture of the biliary tract, gallbladder infarction, gallbladder mucocele, extrahepatic neoplasia, and pancreatitis.[1–11] Biliary surgery has been associated with a high mortality rate in dogs and cats even with advanced diagnostic modalities and critical care monitoring.[7,9,11] Reported mortality rates following biliary surgery vary between 0% and 73% in dogs[3,5,7,9–11] and between 22% and 100% in cats.[4,8] Suggested risk factors include the underlying disease,[7,8] the preoperative condition of the patient,[3,5] the procedure performed,[1] septic bile peritonitis, postoperative hypotension, and creatinine concentration.[9] Most of the studies have evaluated postoperative mortality rate, but have not examined long-term outcome. The objective of the study reported here was to evaluate long-term outcome and factors that affected survival following biliary surgery in dogs.

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The authors thank Dr. Scott Rizzo for assistance with data collection.

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Abbreviations

DIC	Disseminated intravascular coagulation
aPTT	Activated partial thromboplastin time
PT	Prothrombin time
AT III	Antithrombin III
FDP	Fibrin degradation product
GGT	γ-Glutamyltransferase
HR	Hazard ratio
CI	Confidence interval

Criteria for Selection of Cases

Medical records of dogs that underwent biliary surgery between 1994 and 2004 at Colorado State University and Veterinary Specialists of Northern Colorado were evaluated retrospectively. Cases of biliary disease that did not include use of surgery were excluded.

Procedures

Data extracted from medical records included sex, breed, body weight, age at surgery, survival time, concurrent disease, preoperative and postoperative CBC and serum biochemical panel results, coagulation profiles, temperature, heart rate, prevalence of vomiting or diarrhea, anorexia or lethargy at initial evaluation, abdominal ultrasonographic results, and surgical findings. Surgical techniques were divided into 2 groups: a biliary diversion procedure group (cholecystoduodenostomy or cholecystojejunostomy) in which the normal path of bile flow was altered and a nonbiliary diversion procedure group (cholecystectomy, cholecystotomy, choledochotomy, or choledochoduodenostomy). Bacteriologic culture (from bile, liver, or abdominal fluid), antimicrobial susceptibility, and histologic results were recorded. Postoperative complications were evaluated. Hypotension was defined as a systolic blood pressure < 80 mm Hg. Postoperative medications and duration of hospitalization were recorded. A diagnosis of DIC was made by fulfillment of at least 3 of the following criteria as described by Bateman et al[12]: abnormal aPTT or PT value, low plasma AT III activity, high

FDP concentration, or low platelet count. Decreased urine production was defined as urine production < 1 mL/kg/h (0.45 mL/lb/h) despite fluid therapy. Dyspnea was defined as a clinical finding (difficulty breathing) because blood gas analyses were not consistently available. Biliary pathologic findings were classified as primary and secondary. Primary biliary diseases included gallbladder mucocele, inflammatory diseases, trauma, and neoplasia. Secondary biliary diseases included pancreatitis, pancreatic neoplasia, duodenal perforation, and diaphragmatic hernia. The diagnosis of pancreatitis was based on histopathologic lesions because serum amylase and lipase values are not routinely measured in our hospital. The diagnosis of gallbladder mucocele was based on histopathologic findings (cystic mucinous hyperplasia), gross finding of accumulation of mucus in the gallbladder, or ultrasonographic findings (striated or stellate pattern in the gallbladder). A diagnosis of traumatic biliary tract injury was based on historical and surgical findings. The diagnosis of inflammatory biliary disease was based on histologic evidence of cholecystitis or common bile duct cholangitis or fibrosis without evidence of pancreatitis, neoplasia, mucocele, or trauma. Survival times and cause of death were determined on the basis of medical records or phone conversations with owners and referring veterinarians. Short-term survival was defined as < 2 months. Long-term survival was defined as > 2 months.

Statistical analysis—Entry time was defined as the time of surgery. The cause of death was recorded as related or unrelated to the biliary problem, underlying disease, or both. Deaths that occurred perioperatively were recorded as related to the biliary disease. Dogs that died of unrelated disease or were lost to follow-up were censored in the analysis. The Kaplan-Meier product limit method was used to construct survival curves. The 50% probability of survival time and the 1-year survival rates were determined from the survival curves. A log-rank test was used to compare survival curves. Univariate and multivariate Cox proportional hazard analyses were conducted on each variable to identify risk factors for survival after biliary surgery. A hazard ratio was calculated for each variable to evaluate the association between each variable and survival. Survival analysis software[a] was used for all statistical analysis. Unpaired *t* tests were used to compare neutrophil counts in dogs with and without preoperative rupture of the biliary tract. For all comparisons, $P < 0.05$ was considered significant. Data are reported as mean ± SD.

Results

Thirty-four dogs (2 sexually intact females, 2 sexually intact males, 15 neutered males, and 14 spayed females) weighing 16.7 ± 12 kg (36.7 ± 26.4 lb) were included in the study. Five Cocker Spaniels, 2 Beagles, 8 mixed-breed dogs, and a variety of other dog breeds were represented. Primary biliary diseases included gallbladder mucocele (n = 20 dogs), inflammatory diseases (4), trauma (3), and neoplasia (1). Secondary biliary diseases included pancreatitis (n = 4 dogs), pancreatic neoplasia (1), and duodenal perforation (1; **Table 1**). Eleven dogs died or were euthanized for

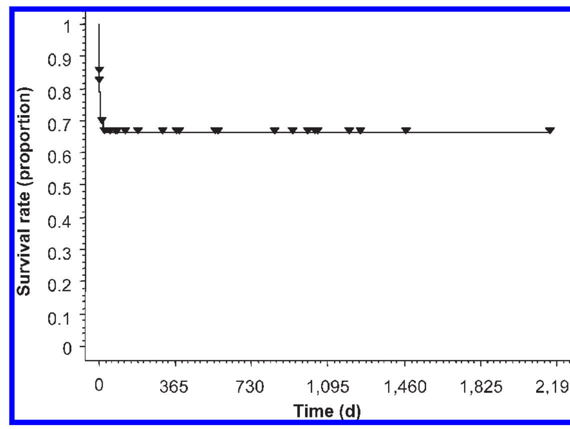

Figure 1—Actuarial survival curve for 34 dogs treated via biliary surgery. Censored dogs are indicated by triangles.

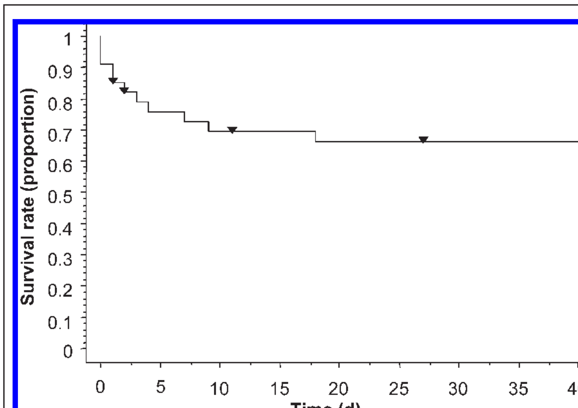

Figure 2—Short-term survival curve for 34 dogs treated via biliary surgery. *See* Figure 1 for key.

Table 1—Biliary surgical procedures (No. of dogs) used in 34 dogs with various underlying diseases that survived or did not survive.

Outcome	Pancreatitis (n = 4)	Trauma (3)	Inflammatory (4)	Neoplasia (2)	Mucocele (20)	Other (1)
Survived	TC (1)	CC (1) CBDPR (1)	CBDPR (1) CC (1) CCD (1)	CCD (1)	CC (15)	CDD (1)
Not alive at time of study	TC (1) CBDS (1) CCJ (1)	CCD (1)	CCD (1)	CC (1)	CC (4) CCD (1)	

TC = Tube cholecystostomy. CC = Cholecystectomy. CBDPR = Common bile duct primary repair. CCD = Cholecystoduodenostomy. CBDS = Common bile duct stenting. CCJ = Cholecystojejunostomy.

reasons related to biliary disease or surgery. Nine dogs died of unrelated causes, and 9 dogs were alive at the time of study. Five dogs were lost to follow-up. Mean follow-up time was 404 ± 552 days. The 50% probability of survival was never reached. One-year and two-year survival rates were 66% (**Figure 1**). The 9 deaths caused by biliary disease occurred within 20 days of surgery (**Figure 2**).

Anorexia (n = 25/34 dogs) and vomiting (25) were the most common clinical signs reported. Diarrhea (n = 5/34 dogs), signs of abdominal pain (9), lethargy (20), hypothermia (2), and hyperthermia (8) were also reported. Abdominal ultrasonography was performed on 26 dogs. Spiculated or stellate gallbladder content characteristic of a biliary mucocele was observed in 19 dogs. Abdominal effusion was reported in 8 dogs, and all had a ruptured biliary tract at surgery. Fluid analysis was not routinely performed preoperatively.

The biliary tract was ruptured at the time of surgery in 12 dogs. Of these dogs, only 10 underwent abdominal ultrasonography. Abdominal effusion was detected via ultrasonography in only 8 of these 10 dogs. There was no significant difference in preoperative band neutrophil counts between dogs with (882 ± 2,015 band neutrophils/μL) and without biliary tract rupture (717 ± 1,779 band neutrophils/μL). However, the preoperative neutrophil count was higher (*P* =

Table 2—Results of preoperative risk analysis for survival of 34 dogs that underwent biliary surgery.

Variable	HR	95% CI	*P* value HR	*P* value likelihood ratio
Weight	0.927	0.84–1.02	0.12	0.05
Age	1.18	1.017–1.36	0.03	0.02
Heart rate	1.03	1.01–1.046	0.001	0.001
Vomiting	0.89	0.23–3.35	0.86	0.86
Anorexia	0.75	0.2–2.8	0.67	0.68
Abdominal pain	1.15	0.29–4.6	0.84	0.84
DIC	2.7	0.33–22	0.35	0.41
Ruptured biliary tract	0.6	0.16–2.3	0.47	0.46
CBD distension on ultrasonography	0.6	0.06–5.9	0.67	0.15

CBD = Common bile duct.

Table 3—Results of hematologic and serum biochemical preoperative risk analysis for survival of 34 dogs that underwent surgery for biliary disease.

Variable	HR	95% CI	*P* value HR	*P* value likelihood ratio
Glucose	0.96	0.94–99	0.02	0.02
BUN	1.03	1.002–1.065	0.04	0.06
Creatinine	1.24	0.72–2.15	0.44	0.47
Phosphorus	1.29	1.05–1.58	0.01	0.03
Calcium	0.92	0.55–1.54	0.75	0.74
Corrected calcium	0.88	0.46–1.7	0.71	0.71
Magnesium	1.34	0.32–5.58	0.69	0.70
Total protein	0.57	0.29–1.15	0.11	0.11
Albumin	0.28	0.074–1.09	0.07	0.05
Globulin	0.5	0.18–1.43	0.2	0.21
Cholesterol	1.001	0.998–1.005	0.47	0.48
Total bilirubin	1.13	1.04–1.22	0.004	0.006
CK	1	1–1	0.20	0.27
ALP	1	1–1	0.02	0.03
ALT	1	1–1	0.098	0.12
AST	1.001	1–1	0.04	0.07
GGT	1.007	1.003–1.011	< 0.001	< 0.001
Sodium	1.02	0.90–1.15	0.76	0.76
Potassium	0.91	0.41–2.01	0.82	0.82
Chloride	0.99	0.89–1.11	0.9	0.9
Bicarbonate	0.95	0.78–1.2	0.63	0.64
Anion gap	1.03	0.91–1.16	0.66	0.67
Inflammatory leukogram	0.68	0.19–2.43	0.56	0.55
Neutrophil count	1.012	0.95–1.07	0.7	0.7
Band neutrophil count	0.95	0.65–1.39	0.8	0.79
Platelet count	1.002	0.999–1.004	0.16	0.21
PCV	1.04	0.97–1.12	0.24	0.26

CK = Creatine kinase. ALP = Alkaline phosphatase. ALT = Alanine aminotransferase. AST = Aspartate aminotransferase.

0.017) in dogs with biliary tract rupture (23,000 ± 9,700 cells/μL) than in dogs without biliary tract rupture (14,763 ± 8,263 cells/μL). Biliary diversion was performed in 6 dogs (5 cholecystoduodenostomies and 1 cholecystojejunostomy; Table 1). Nonbiliary diversion procedures included 22 cholecystectomies, 2 primary repairs of the common bile duct, 2 tube cholecystostomies, 1 common bile duct stent placement, and 1 choledochoduodenostomy. Common bile duct distension was observed at the time of surgery in 6 dogs. To verify its patency, the common bile duct was catheterized normograde in 2 dogs and retrograde in 15 dogs. A jejunostomy, gastrostomy, or esophagostomy feeding tube was placed in 15 dogs. Biliary stenting was performed in 3 dogs by use of a 5-F infant feeding tube placed in a retrograde fashion in the bile duct. The tube was exteriorized through the duodenum and the abdominal wall after a duodenopexy was performed and bile was collected. The tube was removed 8.5 ± 5 days postoperatively.

Preoperatively, risk factors for death included age; preanesthetic heart rate; and BUN, GGT, phosphorus, and bilirubin values (**Tables 2 and 3**). Intraoperatively, biliary diversion surgery was a risk factor for survival (HR, 3.4; 95% CI, 1 to 11.8; *P* = 0.049; likelihood ratio, *P* value = 0.07).

Postoperatively, 4 dogs were hypotensive. Six dogs were treated for DIC with heparin and fresh frozen plasma (2 of those died or were euthanized postoperatively). Three dogs had signs of oliguric renal failure (2 died or were euthanized postoperatively), all of which were hypotensive postoperatively. Three dogs were dyspneic (all died or were euthanized postoperatively). Postoperatively, risk factors for death included hypotension, dyspnea, albumin concentration, globulin concentration, bilirubin concentration, and percentage of band neutrophils (**Table 4**).

Histologic analysis of the gallbladder was available in 23 dogs. Cholecystitis was diagnosed in 11 dogs, cystic mucinous hyperplasia in 10 dogs, and gallbladder necrosis in 9 dogs. Among the 19 dogs with evidence of spiculated or stellate gallbladder contents via abdominal ultrasonography, 10 had cystic mucinous hyperplasia. Three of the 19 had gallbladder mucosal hyperplasia only, 3 had inspissated amorphous material in the gallbladder, 2 had cholecystitis only, and 1 had inspissated bile only. Histologic analysis of the liver performed in 24 dogs revealed cholangitis in 6, cholangiohepatitis in 5, and liver necrosis in 4. Pancreatitis was not a risk factor for death (**Table 5**). However, poor long-term outcome was associated with pancreatitis (*P* = 0.045; **Figure 3**). Other etiologies and bile peritonitis were not risk factors (**Figure 4**; Table 5).

Table 4—Results of postoperative risk factor analysis for survival of 34 dogs that underwent biliary surgery.

Variable	HR	95% CI	*P* value HR	*P* value likelihood ratio
Hypotension	13.7	2.2–87	0.005	0.007
DIC	3.6	0.72–18	0.12	0.13
Decreased urine production	4.5	0.88–24	0.07	0.11
Dyspnea	36	5.9–196	< 0.001	< 0.001
Neutrophil count	0.97	0.9–1.04	0.41	0.38
Band neutrophils	1.28	1.024–1.29	0.02	0.03
PCV	0.89	0.775–1.02	0.1	0.07
Reticulocyte count	1	1–1	0.56	0.52
Platelet count	1.001	0.99–1.01	0.74	0.75
Platelet clumps	3.4	0.6–19	0.16	0.199
Glucose	0.92	0.86–0.98	0.01	< 0.001
BUN	1.01	0.9–1.13	0.84	0.84
Creatinine	0.46	0.05–4.6	0.51	0.39
Phosphorus	1.4	0.74–2.7	0.29	0.31
Calcium	0.08	0.01–0.79	0.03	0.003
Corrected calcium	0.158	0.02–1.48	0.1	0.06
Magnesium	1.35	0.01–226	0.91	0.91
Total protein	0.26	0.1–0.6	0.003	0.002
Albumin	0.005	0.00005–0.42	0.02	0.002
Globulin	0.06	0.006–0.6	0.02	0.01
Cholesterol	0.996	0.99–1.01	0.47	0.44
Total bilirubin	1.2	1.05–1.45	0.01	0.02
CK	1	1–1.001	0.03	0.02
ALP	1	1–1	0.64	0.65
ALT	1.001	0.999–1.003	0.56	0.56
AST	1	0.999–1.001	0.39	0.45
GGT	1.003	0.99–1.02	0.62	0.64
Sodium	1.1	0.9–1.3	0.31	0.31
Potassium	0.34	0.1–1.1	0.07	0.07
Chloride	1.3	1.04–1.55	0.02	0.01
Bicarbonate	0.6	0.4–1.006	0.053	0.04

See Table 3 for key.

Table 5—Results of histopathologic and etiologic risk factor analysis for survival of 34 dogs that underwent biliary surgery.

Variable	HR	95% CI	*P* value HR	*P* value likelihood ratio
Biliary hyperplasia	0.37	0.07–1.9	0.24	0.22
Gallbladder necrosis	2	0.4–9.9	0.4	0.4
Any gallbladder histologic abnormality	1.8	0.2–15.7	0.58	0.56
Liver inflammation or necrosis	0.71	0.16–3.2	0.66	0.66
Cholecystitis	1.1	0.22–5.4	0.92	0.92
Cholangiohepatitis	1.4	0.27–7.2	0.69	0.7
Cholangitis	2.5	0.56–11.3	0.23	0.24
Inflammatory only	0.75	0.09–5.9	0.79	0.78
Mucocele	0.5	0.15–1.66	0.25	0.26
Pancreatitis	3.5	0.93–13.4	0.06	0.09
Traumatic biliary tract rupture	1.12	0.14–8.75	0.9	0.92
Neoplasia	2.1	0.14–8.75	0.47	0.51

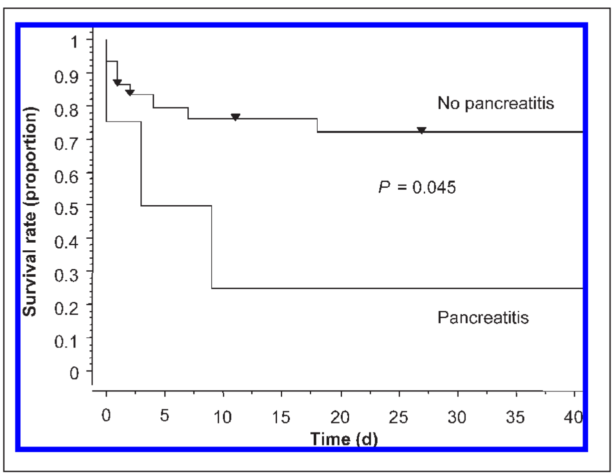

Figure 3—Short-term survival curves for dogs with and without pancreatitis and treated via biliary surgery. *See* Figure 1 for key.

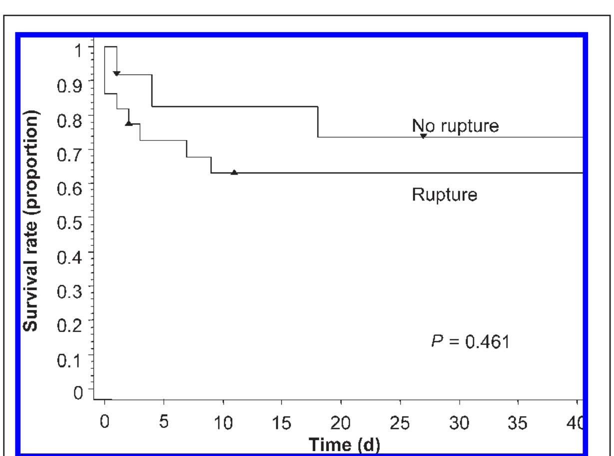

Figure 4—Short-term survival curves for dogs with and without rupture of the biliary tract at the time of biliary surgery. *See* Figure 1 for key.

Bacteriologic cultures from bile, liver, or abdominal fluid were performed in 24 dogs (in 11/12 dogs with preoperative biliary rupture and in 13/21 without biliary tract rupture). Cultures yielded positive results in 8 of 24 dogs. A single bacterial species was isolated in 8 dogs and more than 1 bacterial species was isolated in 5. Bacteria cultured included *Enterococcus* spp (n = 5 dogs), *Escherichia coli* (4), *Staphylococcus* spp, *Streptococcus* spp, *Pasteurella* spp, *Clostridium* spp, and *Propionibacterium* spp. A positive culture result was not a risk factor (HR, 2.6; 95% CI, 0.44 to 15.8; *P* = 0.29; likelihood ratio, *P* value = 0.28). None of the dogs with bile peritonitis had positive results of culture at the time of surgery. Two dogs had septic peritonitis from duodenal perforation and pancreatitis, respectively.

A multivariate model was established that revealed that the HR for the variable biliary diversion was increased by increase in age, GGT activity, and phosphorus concentration and by preoperative hypoglycemia (HR, 10.1; 95% CI, 1.5 to 69; *P* = 0.02; likelihood ratio, *P* value = 0.002).

Discussion

Sixty-six percent of the dogs that underwent surgery were still alive at long-term follow-up. Long-term survival was less favorable in dogs with liver dysfunction, hypotension, and certain diseases that required surgery. Dogs were evaluated most commonly for vomiting, lethargy, or anorexia, which was similar to previous studies.[5,8,9] Most of the dogs in the present study had a gallbladder mucocele, and survival was similar to that reported by Mehler et al.[9] In the study reported here, the survival curve reached a plateau 20 days postoperatively, which indicated that death occurred in the immediate postoperative period.

Preoperative variables related to abnormal liver function were risk factors for survival in this study. High preoperative activities of ALP and GGT and bilirubin concentration reflect the severity of cholestasis. In this study, most dogs had a gallbladder mucocele, which is associated with severe cholestasis. Cholestasis may decrease clearance of bacteria by the liver, predisposing patients to infection and sepsis.[13,14] Hypoproteinemia and hypoalbuminemia were also risk factors for death and are also variables for evaluating liver function. Hypoproteinemia and hypoalbuminemia are also associated with poor outcome in animals with various conditions.[15–20] However, serum albumin or protein concentrations were not risk factors in a recent study[9] in dogs undergoing extrahepatic biliary surgery. High GGT activity was also part of the multivariate model of bile diversion, which made diversion a less desirable surgical procedure for dogs with high GGT activity. High GGT activity may indicate severe cholestasis, which has been associated with increased risks of infection and sepsis.[13,14]

Postoperative complications associated with decreased survival time included dyspnea and hypotension. Causes of dyspnea include pulmonary thromboembolism, aspiration pneumonia, overhydration, or acute respiratory distress syndrome. All 4 dogs that became dyspneic postoperatively died or were subsequently euthanatized. Acute respiratory distress syndrome has been associated with enterotoxemia and sepsis.[21] Inflammatory mediators released during systemic inflammatory response syndrome or sepsis can damage the pulmonary endothelium.[21,22] Because our study was retrospective, it was difficult to assess the cause of dyspnea. Necropsy to further characterize pulmonary lesions was not performed routinely in these dogs. Because the exact cause of death in dogs that died perioperatively could not be determined, it was decided to use the worst-case scenario and count those deaths as attributable to biliary disease and not the underlying disease. Postoperative hypotension was a risk factor in the present study and in another study.[9] Hypoalbuminemia and hypoproteinemia cause greater risk for hypotension.[23] Liver disease has been associated with endotoxemia and sepsis.[13,14] In the study reported here, dogs with a poor prognosis had high liver enzyme values. Consequently, it is possible that these dogs with high liver enzyme values had abnormal liver function and secondary enterotoxemia and sepsis.

The most common indication for biliary surgery in this study was gallbladder mucocele. In a previous study,[9] necrotizing cholecystitis was the most common indication for biliary surgery in dogs, and no cases of gallbladder mucocele were described. Gallbladder mucocele is a recently described condition in dogs, and it may have been grouped previously with cases of necrotizing cholecystitis. In the study reported here, only 9 of the 20 dogs with gallbladder mucocele had histopathologic evidence of cholecystitis. Because 11 dogs with mucoceles had no associated evidence of inflammation, it seems unlikely that mucocele occurred secondary to cholecystitis. Gallbladder mural necrosis has been described in association with gallbladder mucocele in as many as 80% of cases.[24] This is likely a secondary change related to the increased luminal pressure that occurs prior to gallbladder rupture. In the present study, inflammation of the gallbladder was not common in dogs with mucocele. The severity of the necrosis might have been so advanced that an inflammatory reaction was not evident. However, 6 of 11 dogs without inflammation did not have histologic evidence of necrosis.

The underlying disease was not associated with survival in this study, which was in agreement with previous studies[7,9] that examined prognosis associated with bile peritonitis and inflammatory disease of the biliary tree. In the study reported here, the cases were primarily gallbladder mucoceles with or without inflammation; a limited number of cases had other lesions. Gallbladder mucocele seems to have better prognosis than other causes of bile duct obstruction.[9,11] This could not be confirmed in the study reported here because gallbladder mucoceles were overrepresented. Pancreatitis did not appear as a risk factor, but it was associated with a poor prognosis. Most likely, the difference between results of the 2 analyses (risk factor analysis and survival analysis) was caused by the low number of cases of pancreatitis. On the basis of histologic examination of biopsy specimens in the study reported here, 4 dogs had pancreatitis, and it seems likely that biopsy was performed only on dogs with severe disease, which might have caused some bias in the study (underestimation of the true prevalence of pancreatitis). Because significantly poorer survival with pancreatitis was detected among the 4 dogs that had pancreatitis, we are confident that pancreatitis would have been a risk factor for survival if the study had included more such cases. Severe acute pancreatitis in dogs has been associated with multiple organ dysfunction and DIC and carries a poor prognosis.[25]

Bile peritonitis was not a risk factor for death in the present study. Results of Ludwig et al[7] indicate that sterile bile peritonitis is associated with a good prognosis. Septic bile peritonitis has been associated with a high mortality rate.[7] The effect of septic peritonitis on outcome could not be evaluated here because no dog in this study had septic peritonitis. In 2 studies in dogs with gallbladder mucoceles, there was no difference in outcome between dogs with or without preoperative bile peritonitis.[10,11] Nonseptic bile peritonitis, as typically associated with gallbladder mucoceles, has been associated with a good outcome and may not be a surgical emergency.[7,10] With a gallbladder mucocele, bile does not spread in the entire peritoneal cavity. If the mucocele is not associated with cholangiohepatitis or if there is no infection, bile peritonitis tends to be localized and therefore is not associated with a poor prognosis for survival.[10,11]

Surgical techniques used to reestablish flow of bile were associated with survival rate in this study. Biliary diversion (cholecystoduodenostomy and cholecystojejunostomy) was associated with a worse prognosis. Cholecystectomy was performed mostly in dogs with gallbladder mucocele and was associated with a good prognosis. Because gallbladder mucocele is associated with a good prognosis, it might have influenced our results.[11] Biliary diversion procedures have been associated with a number of complications, including reflux of bile into the stomach (alkaline gastritis), ascending cholangitis and cholangiohepatitis, and stricture or leakage of the anastomosis.[26,27] As indicated by results of multivariate analysis in the present study, bile diversion was associated with a worse prognosis in older patients with hypoglycemia, hyperphosphoremia, and high serum GGT activity because these dogs may have been more compromised before biliary diversion. In humans, choledochoenterostomy has been recommended over cholecystoenterostomy,[28] although this is controversial.[29] Roux-en-Y and jejunal limb techniques have been advocated to reduce the incidence of alkaline gastritis and enterobiliary reflux.[27,30] However, these procedures are more technically demanding and have not been evaluated in veterinary medicine.[31] We recommend avoidance of biliary diversion when possible. Bile duct reimplantation should be recommended or a cholecystectomy performed if the common bile duct is patent.

Possible limitations of the study included the reliability of the follow-up information because necropsies were not performed consistently in dogs that died of causes related or unrelated to biliary tract disease in the long term. Another bias was introduced because some dogs with potentially manageable biliary complications may have been euthanatized because of financial constraints. In these types of studies, the issue of how to classify dogs that have been euthanatized is controversial. Two other methods of dealing with this problem have been proposed: exclusion of all animals that were euthanatized and classification of all dogs that were euthanatized as having died of causes unrelated to the underlying disease. Both of these methods are valid, but have the disadvantage of decreasing the number of animals included in the study or of disregarding the likelihood that animals were euthanatized because of a perceived poor quality of life secondary to the underlying disease. In the present study, most of the owners and referring veterinarians who were questioned stated that the decision to euthanatize a dog was made on the basis of detection of disease that was incompatible with a good quality of life; the cause of euthanasia may or may not have been related to the underlying disease.

Another limitation of this study was that treatment was not standardized. Medical management varied among clinicians, and this could have greatly affected the outcome of particular cases. A prospective, multicenter study with a standardized treatment protocol would be necessary to accurately determine whether particular treatments are associated with a better outcome. Finally, a selection bias may have been introduced, as it is possible that animals treated with biliary diversion had a more severe underlying disease than animals treated with other procedures.

Long-term prognosis was guarded in dogs after biliary surgery. However, dogs that survived the early postoperative period had a good long-term prognosis. Dogs with pancreatitis had a poor prognosis. Overall, the prognosis may be worse for dogs that undergo biliary diversion, compared with dogs that do not.

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