Treatment of pancreatitis-associated extrahepatic biliary tract obstruction by choledochal stenting in seven cats

OBJECTIVES: To report the clinicopathological findings and outcome in cats with pancreatitis-associated extrahepatic biliary tract obstruction (EHBO) treated by choledochal tube stenting.

METHODS: Medical records of cats with EHBO secondary to pancreatitis that underwent choledochal stenting were reviewed. Information on outcome was obtained by re-examination of the cat or by telephone interview with the owners.

RESULTS: All cats had pancreatitis confirmed by histopathological examination of biopsy samples (n = 6) or suspected based on gross examination at surgery (n = 1). In six cats, a section of 3.5 to five French gauge red rubber catheter and in one cat a section of 22 G intravenous catheter were used as a choledochal stent. Two cats developed re-obstruction of the biliary tract within a week of the original surgery. One cat had confirmed episodes of ascending cholangitis postoperatively. Two cats had chronic intermittent vomiting in the postoperative period. Two cats died during the perioperative period. Five cats survived to discharge, three of which died seven to 24 months postoperatively and two of which remain alive to date.

CLINICAL SIGNIFICANCE: Choledochal stenting is an alternative to biliary diversion for management of feline pancreatitis-associated EHBO in select cases. However, there may be greater morbidity with this technique in cats compared with dogs.

INTRODUCTION

Surgical diseases of the extrahepatic biliary tract are uncommon in cats. Extrahepatic biliary tract obstruction (EHBO) is most frequently associated with a complex of inflammatory diseases, which include pancreatitis, cholangiohepatitis and cholecystitis and is sometimes complicated by cholelithiasis (Mayhew and others 2002, Buote and others 2006). The proportion of cats with pancreatitis that develop EHBO is unknown but likely to be small. However, when this combination occurs, morbidity and mortality are high (Mayhew and others 2002, Buote and others 2006). Release of proteolytic enzymes and the upregulation of many inflammatory mediators during pancreatitis can cause significant systemic compromise (Cornell and Fischer 2003). In addition, EHBO is an important cause of endotoxaemia that can result in myocardial impairment, renal hypoperfusion, hypotension and gastrointestinal ulceration (Bailey 1976, Alon and others 1982, Green and others 1986).

Choledochal stenting is a frequently employed therapeutic modality for the palliation of malignancies and pancreatitis-induced strictures of the common bile duct (CBD) in human beings (Davids and others 1992, Barthet and others 1994, Smits and others 1996, Guo and others 2003). The use of choledochal stenting in dogs for the management of a variety of biliary disorders has recently been reported and was associated with minimal stent-related morbidity (Mayhew and others 2006).

This study reports the results of choledochal stenting in seven cats with pancreatitis-associated EHBO, which to the authors’ knowledge has not been previously reported in the veterinary literature.

MATERIALS AND METHODS

The medical records of all cats diagnosed with EHBO between March 2004 and January 2006 based on clinicopathological...
and imaging findings were examined. Cats that had an exploratory coeliotomy and had a choledochal tube stent placed were included in the study. Clinicopathological data were collected from the medical records.

Exploratory coeliotomy was completed in each case followed by closer inspection of the extrahepatic biliary tract. In each case, an antimesenteric duodenotomy 3 to 6 cm aboral to the pylorus was performed over the area of the major duodenal papilla. The extrahepatic biliary tract was examined for patency. If it was not possible to demonstrate patency of the biliary tract by catheterisation retrograde through the major duodenal papilla or normograde through a cholecystotomy incision, an alternative procedure was performed and the case was excluded from the study. In cases where catheterisation across the lesion was possible but biochemical and diagnostic imaging tests confirm functional EHBO, choledochal stenting was performed. After copious flushing of the biliary tract with sterile saline solution through the catheter, a small section of absorbable suture material. The duodenotomy was closed in routine fashion.

Outcome was obtained either from the medical record or by re-examination or telephone interview with the owners. Abdominal radiography was used to ascertain the presence or absence of the stent at various points, postoperatively in some cats.

**RESULTS**

Seven cats were included in the study. Clinical signs were present for a range of three to 25 days (median 17 days) before presentation. All cats presented with varying degrees of inappetence. Two of seven cats had a history of vomiting and six of seven cats had clinical icterus. Two cats had palpably small kidneys and one cat had a palpable mass in the cranial abdomen. Two cats had been previously diagnosed with diabetes mellitus and were being treated with insulin administered subcutaneously.

**Laboratory parameters**

A preoperative complete blood count was performed in five cats. Two cats had a leukocytosis (range 24.7 to 10²·10⁹/l). Four cats had a mature neutrophilia (median 19.4·10⁹/l, range 14.6 to 94.8·10⁹/l). Two cats were anaemic (packed cell volume <0.30, range 0.17 to 0.29 l/l).

A complete preoperative serum biochemical panel was available for all cats (Table 1). The total bilirubin concentration was elevated in all cats. Serum activity for alanine aminotransferase and aspartate aminotransferase were also elevated in all cats. Six of seven cats had elevated activities of alkaline phosphatase and gamma-glutamyl transpeptidase. Four of seven cats had elevated serum cholesterol levels. Two cats were hypoalbuminemic. Two cats had elevated creatinine and one cat had elevated blood urea nitrogen preoperatively.

The one-stage prothrombin time (OSPT) and activated partial thromboplastin time (APTT) were measured preoperatively in five cats. OSPT was elevated in four of five cats and APTT was elevated in three of five cats.

Postoperatively, in two cats (cases 6 and 7; Table 2) that were suspected of suffering re-obstruction of the biliary tract, total bilirubin concentration decreased somewhat during the first four to five postoperative days but subsequently increased to concentrations above the preoperative levels. In the other four cats that were discharged from the hospital, total bilirubin decreased rapidly after surgery and was at or close to the reference range within two to nine days.

**Abdominal ultrasound**

All cats underwent preoperative abdominal ultrasonographic examination. Four cats were diagnosed as having varying degrees of pancreatitis. In four cats, a mass-like lesion/thickening at the major duodenal papilla was detected, two of which were also considered to have pancreatitis ultrasonographically. Three cats were diagnosed with pancreatic duct distension: the diameter of the duct in two cats was measured as 3 to 4.5 mm. The diameter of the CBD was 5 to 10 mm in six of seven cats. In the remaining cat, no measurements were taken. In all cats, the gall bladder was enlarged and echoic bile “sludge” was present in five cats. In four cats, the liver was diffusely hyperechoic and in one cat hypoechoic nodules were present within the parenchyma.

**Surgical procedures**

At surgery, all cats were found to have a mass-like thickening at the area where the distal CBD joins the duodenum at the major duodenal papilla. Five cats had extensive gross evidence of diffuse

![FIG 1. Red rubber catheter used as a choledochal stent sutured to the duodenal mucosa with absorbable suture material](image-url)
Pancreatitis-associated EHBO by choledochal stenting

In the remaining case, gross visualisation at surgery revealed a firm, swollen, oedematous area within the body of the pancreas with areas of fat saponification that was assumed to be consistent with pancreatitis. In five cases, chronic active pancreatitis was present with the remaining cat having acute pancreatic necrosis. In the two cats in which a cholecystectomy was performed, cholecystitis with transmural oedema was seen in both cases. All seven cats had liver biopsies performed with histopathologies classified using the World Small Animal Veterinary Association classification of feline inflammatory liver disease (van den Ingh and others 2006): four cats had chronic active pancreatitis, one cat had minimal acute neutrophilic cholangitis, one cat had moderate chronic cholangitis with moderate bile duct hyperplasia, mild fibrosis and periductular fibroplasia and one cat had mild neutrophilic cholangitis with minimal bile duct hyperplasia. Of three cases that had small intestinal biopsies taken, two had evidence of inflammatory bowel disease.

Microbiology
At surgery, samples of bile were collected from six cats and submitted for aerobic and anaerobic culture and sensitivity testing. Aerobic cultures were positive for growth in two cases where an untyped Clostridium species was grown in case 1 and an Enterococcus species in case 4 (Table 2). Anaerobic cultures were positive for growth in two cases where an untyped Enterococcus faecium was grown in case 3 and Escherichia coli alone in case 4 (Table 2). Aerobic cultures were positive for growth in two cases where an untyped Clostridium species was grown in case 1 and an Enterococcus species in case 4. Four cats had the liver parenchyma cultured. Two of these cases (cases 2 and 6) had no growth from the liver culture samples. Case 3 grew Enterococcus faecalis and Enterococcus faecium from aerobic culture of the liver. The liver of case 7 grew a Staphylococcus epidermidis from aerobic culture of the liver.

Histopathology
Pancreatitis was confirmed in all six cases in which a pancreatic biopsy was obtained.

Postoperative morbidity and mortality
Two cats experienced intermittent vomiting of unknown aetiology for several months postoperatively. Two cats developed re-obstruction of their biliary tract within a week of the original surgery. In both cases, serum bilirubin increased after initially decreasing postoperatively and this was accompanied by progressive ultrasonographic distension of the biliary tree. Re-obstruction in one cat was confirmed at a second surgery where a revision cholecystoduodenostomy was performed six days after the first surgery. EHBO had recurred because of the inability of the cat to pass the very thick bile sludge that had developed in the gall bladder either through or around the stent. Upon palpation of the gall bladder, bile was expressed into the duodenum but presumably only at supraphysiological intracholic pressures generated by manual palpation. This case made an uneventful recovery and was discharged from the hospital but was euthanased seven months later because of chronic renal failure. The second case of suspected re-obstruction was not confirmed surgically as euthanasia without necropsy was elected by the owners. In this case, serum total bilirubin, which had initially decreased from 172 μmol/l to 79 μmol/l in the first four postoperative days increased to 209 μmol/l over the subsequent five days.

Abdominal radiography demonstrated that two cats had passed the stents at three and four months postoperatively. In one case, the stent was retained for six months postoperatively. This cat was experiencing episodes of intermittent ascending cholecystitis confirmed by a positive culture of E coli and Enterococcus faecium from a bile sample obtained by cholecystocentesis. The stent was removed by grasping it with endoscopic biopsy forceps and removing it orally. Mineralised concretions were present around the tip of the stent that re-obstructed the gall bladder, bile was expressed through or around the stent. Upon palpation of the gall bladder, bile was expressed into the duodenum but presumably only at supraphysiological intracholic pressures generated by manual palpation. This case made an uneventful recovery and was discharged from the hospital but was euthanased seven months later because of chronic renal failure. The second case of suspected re-obstruction was not confirmed surgically as euthanasia without necropsy was elected by the owners. In this case, serum total bilirubin, which had initially decreased from 172 μmol/l to 79 μmol/l in the first four postoperative days increased to 209 μmol/l over the subsequent five days.

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DISCUSSION

This study reports the results of choledochal stenting in seven cats with pancreatitis-associated EHBO. Alternatives to traditional biliary diversion procedures, such as cholecystoduodenostomy and cholecystojejunostomy, have been investigated for several reasons. Short-term mortality with these procedures has been shown to be 36 to 57 per cent in two recent studies of feline EHBO (Mayhew and others 2002, Buote and others 2006). Developing less complex surgical solutions for feline EHBO, thereby decreasing surgical and anaesthetic time, may reduce morbidity and mortality based on recent observations that profound hypotension during anaesthesia develops frequently after 45 to 60 minutes in these cases and is often not responsive to vasopressor therapy (Mayhew and others 2002, Buote and others 2006). Although the choice of surgical procedure may have a bearing on surgical time and long-term morbidity, there is strong evidence to suggest that peri-operative mortality may have more to do with systemic compromise from associated endotoxaemia, hypotension and multi-organ dysfunction than with the nature of the surgical procedure being performed (Bailey 1976, Alon and others 1982, Green and others 1986, Mehler and others 2004).

Long-term morbidity in cats that have undergone biliary re-routing procedures includes ascending cholecystitis, enterocolitis stricture, recurrence of EHBO, chronic vomiting and diarrhoea secondary to exocrine pancreatic insufficiency (Tangner and others 1982, Mayhew and others 2002, Buote and others 2006). Choledochal stenting does not result in a permanent alteration of biliary tract anatomy and so theoretically may avoid some of these complications. In a recent report of 13 dogs treated with choledochal stenting for a variety of biliary disorders including EHBO and biliary tract trauma, none of the dogs had recurrence of EHBO, evidence of clinically overt ascending cholangitis or other major complications (Mayhew and others 2006). However, it is clear that the underlying pathogenesis of feline EHBO is very different from the condition in dogs. Most cases of feline EHBO are associated with a complex of chronic inflammatory diseases of the pancreas, intestines and hepatobiliary tract, whereas canine EHBO is most frequently associated with more acute pancreatitis (Fahie and Martin 1995, Mayhew and others 2002, Buote and others 2006). In this study, pancreatitis was the suspected aetiology of EHBO based on gross pathological appearance at surgery; however, neoplasia could not be ruled out intra-operatively as these processes can appear very similar. Choledochal stenting in cats with malignant disease may provide short-term palliation although this has not been described. Unfortunately, malignant causes of feline EHBO are associated with a grave prognosis (Mayhew and others 2002, Buote and others 2006). Intraoperative frozen section histopathology or cytological evaluation of impression smears from biopsies may be helpful in discerning these diseases. Even given these modalities, it may be possible to misdiagnose these cases as a neoplastic as well as an inflammatory condition may be occurring concurrently. It may be difficult to aspirate or biopsy multiple areas of what can appear as quite a large and inflamed mass of soft tissue at or close to the major duodenal papilla.

In the cats reported in this study, several important complications did occur. Two cats experienced re-obstruction of the biliary tract with the stent in place. In one case, at re-operation, it was discovered that thick bile was unable to pass through or around the five Fr stent that had been placed. In the second case, where a 22 G intravenous catheter had been used as the stent, no second surgery was permitted by the owner, so the reason for re-obstruction remains unknown. However, the fact re-obstruction occurred using both the smallest and largest catheter sizes, albeit different types, in these cats is concerning. In the authors’ experience, it is difficult to place stents larger than five Fr size and so there may be no option to place larger stents. In canine cases, it has been observed that despite blockage of the stent lumen after time, drainage can continue around the stent (Mayhew and others 2006). In human beings where polyethylene stenting of the biliary tract is frequently performed, it is recognised that stent occlusion will occur in 30 per cent of cases within a month (Davids and others 1992, Guo and others 2003). With much smaller stent sizes used in cats, it is likely that stent occlusion will occur even sooner. This is because of a well-documented process of protein adsorption to the stent wall followed by adherence of bacteria, food fibres and bilirubin that eventually cause stent occlusion because of biofilm formation (Groen and others 1987, Weickert and others 2001, Leung and others 2002). It may be reasonable to advise caution with choledochal stent placement in cats where thick bile sludge is already present as early stent occlusion may cause rapid recurrence of EHBO as occurred in one cat in this study. The number of feline cases in the present study is small and therefore it is difficult to make valid conclusions from this data alone.

The ideal clinical scenario after choledochal stenting in feline pancreatitis-associated EHBO is that following successful medical treatment of pancreatitis, periductal inflammation and oedema subside to the extent that EHBO resolves. Subsequently, after suture dissolution, gastrointestinal peristalsis will hasten the excretion of the stent in the faeces. Stent retention can easily be detected as red rubber catheters as small as 3.5 French gauge can be seen by plain radiography postoperatively. Stent passage in the faeces occurred within four months in two of the three cats that were followed up radiographically long term. In the remaining cat, stent retention for six months was associated with repeated episodes of ascending cholangitis, which manifested with clinical signs of pyrexia, vomiting, diarrhoea and elevations of liver enzymes. In this case, endoscopic stent removal was elected at six months and was simple to perform. Concretions of calcium carbonate, the most common composition for feline choleliths, were found covering the segment of stent within the CBD. Unfortunately, this cat, despite continuing to do well clinically, continues to have recurrent episodes of ascending cholangitis. The authors suspect that the underlying...
inflammatory biliary tract disease may be an important contributor to the ongoing clinical signs in this case rather than them being attributed to stent retention alone.

Stent retention has been shown, in an experimental study, to cause a variety of pathological alterations to the biliary tract that have relevance to the way clinical feline EHBO is managed (Sung and others 1992). In all cats, where choledochal stenting across the sphincter of oddi was performed, the biliary tract was colonised with duodenal bacteria within two weeks of surgery. All cats in the study had thick biofilm formation within the stents demonstrated by electron microscopy. Interestingly, however, only one of six cats that had stent implantation within the CBD but not crossing the major duodenal papilla demonstrated bacteriuria and none had biofilm formation, development of stent occlusion or EHBO (Sung and others 1992). This suggests that interference with the function of the sphincter of oddi, in these healthy cats, was particularly detrimental. Although clear differences are present between this population of healthy experimental cats and the cats with clinical disease in our study, it seems reasonable based on this information to minimise the time that choledochal stents are left in place in cats. Based on this information and our clinical observations, the authors recommend that radiographic follow-up is performed at two to three months and if clinical signs have resolved, endoscopic stent removal be considered at that time. Furthermore, it is suggested that sutures used to anchor the stents temporarily to the duodenal wall be of a monofilament absorbable nature so that stent removal can occur after suture dissolution. Ideally, a prospective study will evaluate the need for postoperative stent removal in those cats where stent retention occurs but is difficult to perform because of the uncommon nature of this condition. It appears from the results of this small case series that morbidity is higher in cats than in dogs when choledochal stenting is used to treat pancreatitis-associated EHBO.

Based on these findings, the authors would make the following suggestions concerning the use of choledochal stenting in the management of confirmed or suspected pancreatitis-associated EHBO in cats; in cases where, at surgery, the CBD cannot be catheterised across the lesion, a biliary diversion should be performed or a choledochostomy tube placed. In cases where the CBD can easily be catheterised but functional EHBO has been confirmed preoperatively by the presence of typical laboratory and imaging parameters biliary diversion, choledochal stenting or choledochostomy tube placement should be considered. Choledochostomy should also be performed in cases with necrotic gall bladders and arguably for cats with cholecystitis to prevent recurrence. However, it should be noted that choledochocystotomy results in loss of the use of the gall bladder for subsequent biliary diversion if initial biliary decompressive procedures fail. Recently, intermitten cholecystocentesis has been described for the management of three dogs with pancreatitis-associated EHBO (Herman and others 2005). To the authors’ knowledge, this technique has not been evaluated in cats. Irrespective of the decompressive technique used, the quality of postoperative management is likely to play a major role in determining success of the treatment.

The results of this study demonstrate that choledochal stenting for management of feline pancreatitis-associated EHBO can be performed simply and successfully but is not without associated morbidity and mortality. Because of the small non-randomised case number and the lack of a control population, this report cannot demonstrate any superiority of the technique over other described treatment options such as simple flushing of the biliary tract, intermittent drainage by choledochocystotomy, choledochostomy tube placement or biliary diversion procedures. Evaluation is made more difficult by the variation in underlying pathologies, and variations in stent and suture types used in these cats. Choledochal stenting should be considered another treatment option and prospective randomised controlled studies should be performed to compare treatment modalities for this challenging disease.

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