

Pancreatic surgical biopsy in 24 dogs and 19 cats: postoperative complications and clinical relevance of histological findings

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OBJECTIVE: To assess the immediate postoperative complications associated with pancreatic biopsy in dogs and cats and review the clinical relevance of biopsy findings.

METHODS: Retrospective review of clinical records from two referral institutions for cases undergoing pancreatic biopsy between 2000 and 2013.

RESULTS: Twenty-four dogs and 19 cats that had surgical pancreatic biopsy had sufficient detail in their clinical records and fulfilled the inclusion criteria. Postoperative complications were seen in 10 cases of which 5 were suggestive of post-surgical pancreatitis. Two patients were euthanased within 10 days of surgery because of the underlying disease; neither suffered postoperative complications. Pancreatic pathology was found in 19 cases, 7 cases showed no change other than benign pancreatic nodular hyperplasia, and no abnormalities were seen in 18 cases.

CLINICAL SIGNIFICANCE: Complications may be encountered following surgical pancreatic biopsy, although the risk should be minimal with good surgical technique. Pancreatic biopsy may provide a useful contribution to case management but it is not clear whether a negative pancreatic biopsy should be used to rule out pancreatic disease. Dogs were more likely to have no significant pathology found on pancreatic biopsy than cats, where chronic pancreatitis was the most common finding.

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INTRODUCTION

Surgery of the pancreas in dogs and cats can be undertaken for both therapeutic and diagnostic purposes. Pancreatic biopsy can facilitate diagnosis of disorders such as acute and chronic pancreatitis, and neoplasia. Pancreatitis can be difficult to diagnose accurately ante-mortem because no diagnostic test has perfect sensitivity and specificity, but histological examination has been suggested as the gold standard for diagnosis in dogs (Watson 2004), cats (DeCock *et al.* 2007) and humans (Etemad & Whitcomb 2001). Several surgical techniques have been described for pancreatic biopsy in dogs and cats. Suture fracture and blunt dissection/ligation techniques have been described using both lesion-targeted and anatomically targeted (randomly chosen) biopsy sites (Allen

et al. 1989, Cornell 2012). In one study comparing outcome in healthy dogs using either suture fracture or dissection and ligation for open surgical biopsy, more severe inflammation was apparent histologically in the suture fracture group when necropsied at 7 days post surgery although the clinical relevance was not clear (Allen *et al.* 1989). One other study described suture fracture for open surgical biopsy in healthy cats, and found no histological evidence of pancreatitis at necropsy 4 weeks postoperatively (Lutz *et al.* 1994). Clamshell biopsy using cup biopsy forceps has also been reported in healthy adult dogs but these cases were euthanased at the end of surgery without necropsy so no assessment of postoperative effect could be made (Cordner *et al.* 2010).

Postoperative complications of pancreatic surgical biopsy were well documented in humans when it was the standard approach

(Schultz & Sanders 1963, Lightwood *et al.* 1976); however, since the 1990s operative biopsy has largely been replaced by endoscopic and ultrasound-guided biopsy/aspiration. There is one published study evaluating reliability of needle aspiration (from two sites) under ultrasound guidance as a less invasive method for collecting pancreatic samples in dogs (Cordner *et al.* 2010). However, only 18 of 27 (66.7%) aspirates yielded cytology smears considered to be of diagnostic quality and this technique has not come into widespread clinical use. In humans, endoscopic ultrasonography (EUS) is considered superior to magnetic resonance imaging (MRI) and computed tomography (CT) in detecting pancreatic masses, and allows precise placement of a needle into suspicious lesions. EUS-guided fine needle aspirate is the principal technique applied to obtain cytological diagnosis of malignancy *versus* other pathology (Chang *et al.* 1997, Vazquez-Sequeiros 2007, Hassan & Hawes 2012). Although EUS has been briefly discussed in dogs and cats (Gaschen *et al.* 2003, Schweighauser *et al.* 2009) it has not come into general clinical use.

The majority of the reports of postoperative complications following pancreatic surgery in dogs and cats relate to partial pancreatectomy and tumour resections (Mehlhaff *et al.* 1985, Dunn *et al.* 1993, Tobin *et al.* 1999, Polton *et al.* 2007, Wouters *et al.* 2011). There is one published experimental study investigating complications of open surgical pancreatic biopsy in clinically healthy cats where none developed biopsy related complications (Lutz *et al.* 1994). Cordner *et al.* (2010) documented the effect of pancreatic aspiration and biopsy on serum pancreatic enzyme concentrations in healthy animals but these were used for a non-recovery surgery teaching laboratory, which ruled out postoperative assessment. Recent studies have focussed more on laparoscopic biopsy in cats and dogs. An experimental study compared trauma induced by standard endoscopic instruments and harmonic scalpel biopsy (Barnes *et al.* 2006). Each method was used in six healthy dogs and necropsy carried out at either 4 or 14 days postoperatively. No clinically apparent complications were seen in either group at 14 days although increased pancreatic inflammation and adhesions were appreciable in the harmonic scalpel group. Laparoscopy-assisted biopsy has been described in 20 clinical patients, however, procedural details and postoperative progress were not provided (Webb & Trott 2008). Laparoscopic biopsy in six normal cats using a 5-mm punch biopsy forceps with two teeth identified mild adhesions (two of six) and neovascularisation (three of six) at a second surgery 1 month later (Cosford *et al.* 2010). These authors also described microscopic evidence of a focal pancreatitis or stentitis in five of six cats; these changes were interpreted as normal reparative processes after the biopsy injury.

To the authors' knowledge, postoperative complications, usefulness and yield of pancreatic biopsy samples collected during exploratory abdominal surgery in clinical cases have not yet been reported.

It was hypothesised that surgical pancreatic biopsy in dogs and cats, performed as part of an exploratory abdominal surgery on clinical cases, would be associated with minimal complications provided appropriate surgical technique was used. An additional aim of this study was to assess how frequently a single biopsy would return a significant pathological finding.

MATERIALS AND METHODS

The time frame for the study was between 2000 and 2013. Databases from two referral institutions were searched for client-owned animals undergoing pancreatic surgical biopsy as part of an exploratory abdominal surgery. Data retrieved included signalment, pancreatic biopsy technique, additional procedures performed during the same anaesthetic, histopathological findings and complications over a 10-day postoperative period. Complications were considered any adverse event occurring in the first 10 days postoperatively, as described in the contemporaneous records, identified on laboratory testing or diagnostic imaging. Complications were grouped as those most likely related to the underlying disease, and those most likely relating to the surgical procedure. There are currently no standard criteria for identification of postoperative pancreatitis, and no consistent criteria reported in previous veterinary studies, whether clinical or experimental. On the basis of the lack of definitive criteria, patients with suggestive clinical signs, serum biochemistry results or diagnostic imaging findings were considered to have "suspected postoperative pancreatitis". Cases were excluded if they did not have full histological reports for all biopsy samples or where clinical records were incomplete. Cases undergoing major abdominal surgery such as hepatic lobectomy in conjunction with pancreatic biopsy were also excluded, as were those euthanased within the first 72 hours of surgery based on the severity of the pre-existing disease and/or identification of a poor prognosis from histological reports.

RESULTS

Forty-three cases were identified that met all of the study criteria, 19 cats and 24 dogs. Of the 19 cats, the majority (16) were domestic shorthair (DSH), with one each of Egyptian, Tonkinese and Siamese breeds. A wider range of dog breeds were represented, with three Labrador retrievers, two each for German shepherd dog, Border collie and miniature schnauzer and one each of crossbreed, Jack Russell terrier, English bull terrier, English bulldog, flatcoat retriever, West Highland white terrier, Rhodesian ridgeback, Maltese, whippet, Briard, boxer, Italian spinone, English springer spaniel and Papillon. The median age for cats was 7 years (range: 1 to 15 years) and for dogs was 6 years (range: 18 months to 12 years).

Surgical technique used for pancreatic biopsy was predominantly suture fracture (Cornell & Fischer 2003), although wedge biopsy using two overlapping haemostatic sutures analogous to a hepatic wedge biopsy was used in one case and in a single case a crushing haemostat was placed on the right pancreatic limb followed by a transfixation ligature in the crushed tissues.

One cat was diagnosed with pancreatic adenocarcinoma but showed only mild clinical signs at the time of surgery; it was euthanased one month later because of clinical relapse. Two dogs were euthanased 7 and 8 days after surgery at the owners request following histological confirmation of diffuse hepatic carcinoma

and hepatic cirrhosis, respectively. None of these cases had any postoperative surgical complications documented between surgery and the time of euthanasia.

Postoperative complications were recorded in 10 cases (7 dogs and 3 cats) of which 2 had abdominal ultrasound performed. These complications included vomiting, cranial abdominal pain, nausea, anorexia and lethargy, which could all be considered suggestive of but not diagnostic for pancreatitis (Steiner 2010, Washabau 2010).

In one cat with abdominal pain and nausea postoperatively, abdominal ultrasound identified pancreatic oedema and localised mesenteric hyperechogenicity suggestive of pancreatitis complications and pancreatitis. Haematology showed mild neutrophilia and mildly increased alkaline phosphatase with no other abnormalities. A dog which had only a pancreatic biopsy and a gall bladder aspirate performed became lethargic, pyrexia, developed peripheral oedema, ascites and abdominal pain all within 48 hours of surgery. Abdominal ultrasound in this patient identified changes consistent with generalised septic peritonitis, and blood samples showed neutrophilia, hypoalbuminaemia and increased hepatic enzyme activities. Abdominal cytology was consistent with septic peritonitis but without evidence of gastrointestinal leakage. The owners elected euthanasia but declined a necropsy. This was the dog whose biopsy was collected by crushing pancreatic tissue with a haemostat, creating a zone of necrotic tissue at the biopsy site within which there was a ligature of braided suture material. It was considered possible in this case that peritonitis was a sequel to postoperative pancreatitis. Two dogs and one cat had abdominal pain, nausea and poor appetite lasting 1 to 6 days after surgery thought to reflect post-surgical pancreatic complications and pancreatitis although this was not confirmed. One dog which had multiple small and large intestinal biopsy samples collected developed generalised septic peritonitis postoperatively with pyrexia, anorexia, vomiting, leucocytosis, hypoalbuminaemia and a septic abdominal exudate confirmed on abdominocentesis. Although no necropsy was performed, abdominal cytology suggested leakage from a gastrointestinal biopsy site. Four patients had pre-existing vomiting, nausea and anorexia which continued to some degree immediately postoperatively and was considered due to underlying disease processes (gastroduodenal ulceration in one dog and three cases of feline triaditis).

Histology on pancreatic samples gave a definitive histopathological diagnosis in 19 cases (44.1%, 13 dogs, 6 cats). Benign nodular hyperplasia (BNH) was the only finding in 7 cases (16.2%, 1 dog, 6 cats), and no abnormalities were seen in 18 cases (41.8%, 12 dogs, 6 cats). All patients had a single biopsy taken, with the location based on visible abnormality in only one case (subsequently diagnosed with adenocarcinoma) and surgeon preference in all other cases where either the changes were diffuse or there were no visible abnormalities. Thirty-two cases (74.4%) had biopsy samples collected from the right limb of which half returned a positive finding and half either BNH or no abnormality; seven were collected from the left limb (16.2%) of which two returned a positive finding and four either BNH or no abnormality and the location was unrecorded in four cases (9.3%). In all cases where the subjective assessment by the surgeon was that

there were no significant gross abnormalities, this was borne out by histological findings of no abnormalities or BNH only.

Tables 1 (cats) and 2 (dogs) summarise the surgical procedures performed, pancreatic biopsy technique and location, and pathologies identified. Table 3 summarises the distribution of pancreatic pathologies between dogs and cats.

DISCUSSION

In the cases reported here, a histological diagnosis of pancreatic pathology was made in less than half of the cases. Of these, 13 had evidence of chronic pancreatitis, 3 had pancreatic acinar atrophy consistent with exocrine pancreatic insufficiency (EPI) when taken in combination with their clinical signs and laboratory findings, 1 had secondary pancreatic atrophy and 1 had pancreatic neoplasia. Where BNH was the only finding it was not considered to be clinically significant as BNH shows a positive correlation with age regardless of the presence or absence of pancreatic inflammation, fibrosis or necrosis and has been previously described as an incidental finding in older dogs, cats and humans (Nelson & Couto 1998, Newman *et al.* 2005, DeCock *et al.* 2007, Watson *et al.* 2007). Although the numbers are too small for meaningful analysis, it is interesting to note that dogs were more likely to have a negative pancreatic histology than cats.

Where significant pancreatic pathology is not identified on a biopsy sample, as with just over half of the cases in this study, this is generally taken by clinicians to mean that pancreatic disease can be excluded. However, Newman *et al.* (2004) studying dogs from a referral hospital population found that gross inflammatory lesions were only rarely (4 of 73; 5.4%) recognisable on necropsy examination of pancreata which had been removed entirely from the abdomen. Comprehensive histological examination of multiple slices taken along the full length of the same pancreata confirmed abnormalities were actually present in 43 of 73 (58.9%) cases. This study also suggested that if inflammatory lesions were present, they were not preferentially localised to any particular site within the pancreas and were more likely to be small and discrete than diffuse. On the basis of these findings it appears reasonable to consider that in the absence of grossly identifiable abnormalities a single biopsy from the right limb of the pancreas as is currently suggested (Cornell 2012) may not be a reliable method of whole organ assessment. It appears more logical that multiple samples from a variety of locations within the pancreas would procure a greater diagnostic yield than a single site biopsy. However, in veterinary cases there may be concerns that this approach might not be feasible because of size constraints and potential morbidity although there are no studies to confirm or disprove this at the present time. Current surgical recommendations are that where diffuse pancreatic disease is present or suspected, a pancreatic biopsy should be taken at the distal right limb because of the distance from the duct system and ready surgical access (Cornell 2012). This was the case in the majority of the cases in this series, with only a small number having left limb biopsies. The site of biopsy was unrecorded in a few cases. As almost all cases in this study had biopsy samples

Table 1. Surgical procedures performed, pancreatic biopsy technique and location, and pathologies identified for 19 cats

	Biopsy technique	Location of biopsy	Other procedures performed	Pancreatic histology	Complications	Other pathology found
1	Suture fracture	Right limb	MLN biopsy	Chronic pancreatitis with fibrosis	None	None
2	Suture fracture	Right limb	MLN biopsy	Adenocarcinoma	None, PTS one month later for relapse	None
3	Suture fracture	Right limb	SI and MLN biopsy	Chronic pancreatitis	None	None
4	Suture fracture	NR	Gastric, liver, SI and MLN biopsy	Chronic pancreatitis	Abdominal pain (severe) and nausea	Hepatic lipidosis, IBD
5	Suture fracture	Right limb	Gastric, liver and MLN biopsy	NAD	None	None
6	Suture fracture	Right limb	Liver, SI and MLN biopsy	Chronic pancreatitis	None	IBD, hepatic nodular hyperplasia
7	Suture fracture	Right limb	Gastric, liver, SI and MLN biopsy. Bile aspirate	Pancreatitis	None	Coronavirus enteritis
8	Suture fracture	Right limb	Liver, gastric, SI, renal and MLN biopsy, bile aspirate	Pancreatitis	None	Triaditis, chronic interstitial nephritis
9	Suture fracture	Right limb	Liver, gastric, SI and MLN biopsy	Chronic pancreatitis	None	Triaditis
10	Suture fracture	Right limb	Liver, SI and MLN biopsy	Chronic pancreatitis	None	Triaditis
11	Suture fracture	Right limb	Liver, gastric, SI and MLN biopsy	Chronic pancreatitis	None	Triaditis,
12	Suture fracture	Left limb	Liver, SI, colonic and MLN biopsy. Bile aspirate	NAD	Abdominal pain, pyrexia, inappetence. Pancreatic oedema and mixed echogenicity on ultrasound	Hepatic lipidosis, portal hepatitis, mild jejunitis, colitis
13	Suture fracture	Right limb	Pharyngostomy tube placement, liver gastric and SI biopsy	BNH	None	Subcapsular hepatic fibrosis, biliary hyperplasia, gastric spirochaetes
14	Suture fracture	Right limb	Resect ovarian remnant, liver, gastric, SI and MLN biopsy	NAD	None	IBD, gastritis
15	Suture fracture	Left limb	Splenic biopsy, liver, SI and MLN biopsy	Chronic pancreatitis with pancreatic fibrosis	None	Triaditis, splenic nodular regeneration
16	Suture fracture	Junction of body and left limb	Liver, gastric, SI and MLN biopsy	NAD	None	T cell lymphoma in liver, SI and MLN
17	Suture fracture	Right limb	Liver, gastric, SI and MLN biopsy. Bile aspirate	NAD	None	IBD, hepatic lipidosis
18	Suture fracture	Left limb	Cholecystotomy, SI, MLN and liver biopsy	Acute on chronic pancreatitis	None	Suppurative CH, duodenitis
19	Suture fracture	Right limb	Liver, MLN and SI biopsy	Lympho-plasmacytic pancreatitis	None	CH, biliary intrahepatic cysts (congenital), neutrophilic duodenitis

NR Not recorded, NAD No abnormality detected, BNH Benign nodular hyperplasia, CH Cholangiohepatitis, IBD Inflammatory bowel disease, MLN Mesenteric lymph node, SI Small intestine, PTS Put to sleep

collected using a single technique (suture fracture) it was not possible to assess whether technique influenced complication rates other than observing that the case in which an inappropriate technique was used suffered significant complications.

Anecdotally, there is a perception that surgery involving the pancreas carries a significant risk of pancreatitis, although confirming that postoperative pancreatitis is present is challenging. The variability in severity and nature of clinical signs associated with pancreatitis, particularly in cats, makes accurate recognition of postoperative pancreatitis difficult on the basis of

clinical examination. Abdominal pain could be a result of inadequate analgesia; surgical procedures and technique may influence occurrence of postoperative complications; analgesics and other medications may mask the presence of a clinical pancreatitis or induce nausea. Currently, clinical diagnosis of postoperative pancreatitis is subjective and based largely on recognition of suggestive clinical signs, characteristic changes in biochemical assays (if performed) and suggestive findings on abdominal ultrasound (pancreatic enlargement, fluid accumulation around the pancreas and altered echogenicity). On the basis of suggestive

Table 2. Data relating to surgical procedures performed, pancreatic biopsy technique and location, and pathologies identified for 24 dogs

	Biopsy technique	Location of biopsy	Other procedures performed	Pancreatic histology	Complications	Other pathology found
1	Suture fracture	Left limb	Liver biopsy	BNH	None	Hepatic cirrhosis and biliary hyperplasia
2	Suture fracture	Right limb	Gastric, liver and SI biopsy	NAD	None	Eosinophilic enteritis
3	Suture fracture	Right limb	Liver biopsy	BNH	None	None
4	Suture fracture	Right limb	None	BNH	None	None
5	Suture fracture	Right limb	Gastric, liver and SI biopsy	PAA	None	None
6	Crushing forceps across pancreatic tissue plus transfixing ligature	Right limb	Bile aspirate	BNH	Severe pancreatitis and septic peritonitis, PTS	None
7	Suture fracture	Right limb	Liver biopsy	Chronic pancreatitis	Abdominal pain (severe). PTS 3 months later due to progression of pancreatitis	Acute hepatitis
8	Suture fracture	NR	Liver, SI and MLN biopsy	NAD	None	Haemorrhagic telangiectasia
9	Suture fracture	NR	Liver and SI biopsy, splenic aspirate	NAD	Abdominal pain (moderate) and nausea	IBD, hepatic lymphangiectasia
10	Suture fracture	Right limb	SI biopsy	NAD	Abdominal pain (moderate)	Enteritis, non-specific
11	Suture fracture	Right limb	Gastric, liver and SI biopsy	NAD	None	Microvascular hepatic dysplasia
12	Suture fracture	Right limb	Pancreas, liver, SI, LI and MLN biopsy	PAA	None	IBD
13	Suture fracture	NR	Gastric, SI including one ileum, colonic and MLN biopsy	NAD	Septic peritonitis, PTS	IBD
14	Suture fracture	Right limb	Gastric, liver, SI and MLN biopsy	NAD	Localised pancreatitis on ultrasound exam	IBD, hepatopathy
15	Suture fracture	Right limb	Liver and MLN biopsy	BNH	None. PTS 8 days post surgery based on histological diagnosis	Carcinoma, metastatic
16	Suture fracture	Left limb	Liver biopsy, bile aspirate	BNH	None. PTS 8 days post surgery based on histological diagnosis	End stage hepatic cirrhosis
17	Wedge	Body	Liver biopsy, splenic and bile aspirate	NAD	None	Cholestasis, extramedullary haematopoiesis
18	Suture fracture	Right limb	Liver, gastric, SI and MLN biopsy	NAD	None	IBD, mild vacuolar hepatopathy
19	Suture fracture	Right limb	Liver, gastric, SI and MLN biopsy	Chronic pancreatitis	None	IBD, vacuolar hepatopathy
20	Suture fracture	Right limb	Liver, gastric and MLN biopsy	NAD	None	Hyperplastic gastritis
21	Suture fracture	Right limb	OVH, liver, gastric and MLN biopsy	NAD	Abdominal pain (moderate-severe) and inappetence	Eosinophilic enteritis with gastric spirochaetes
22	Suture fracture	Right limb	Biopsy bladder, kidney	NAD	None	Erosive cystitis
23	Suture fracture	Right limb	Gastric, SI and MLN biopsy	PAA	None	None
24	Suture fracture	Right limb	Gastric, SI and MLN biopsy	Secondary pancreatic atrophy	None	Eosinophilic enteritis, neutrophilic colitis

NR Not recorded, NAD No abnormality detected, BNH Benign nodular hyperplasia, MLN Mesenteric lymph node, SI Small intestine, IBD Inflammatory bowel disease, PAA Pancreatic acinar atrophy, OVH Ovariectomy, PTS Put to sleep

Table 3. Distribution of pancreatic pathology between dogs and cats

Pancreatic histology	Number of cases (total)	Dogs	Cats
Pancreatic nodular hyperplasia	7	6	1
No pathology identified	18	13	5
Pancreatic neoplasia (adenocarcinoma or lymphoma)	1	0	1
Pancreatic acinar atrophy	3	3	0
Chronic pancreatitis	13	2	11
Secondary pancreatic atrophy	1	1	0

It is of interest that pancreatic nodular hyperplasia and absence of histological abnormality were both more common findings in dogs than in cats, while chronic pancreatitis was a more common findings in cats than in dogs

clinical signs, in one case corroborated by findings on diagnostic imaging, there were five cases in this study with suspected postoperative pancreatitis. One of these was considered possibly related to surgical technique. Although the numbers are too small for definitive comment, it is interesting that six of seven dogs with postoperative complications showed cranial abdominal pain compared with zero of three cats; this could reflect differences in pain assessment between the species or a genuine difference. The variable accuracy of biochemical markers for diagnosis of pancreatic inflammation make it difficult to definitively diagnose postoperative pancreatitis on this basis alone, and the magnitude of change in a biochemical marker may not accurately reflect the clinical severity. Canine and feline specific pancreatic lipase immunoreactivity (PLI) have been shown to have a sensitivity of only 78 and 79%, respectively for pancreatitis (Forman *et al.* 2009, McCord *et al.* 2012). The situation is further complicated by the fact that there is limited data regarding whether biopsy in and of itself may cause elevation in these biochemical markers. The combination of pancreatic aspirate and clamshell biopsy in healthy dogs was associated with increased serum trypsin-like immunoreactivity but not canine PLI in one study with cumulative damage to the pancreas noted (Cordner *et al.* 2010). In cats, pancreatic biopsy using a 4-mm biopsy punch led to significant increases in serum feline PLI concentrations but not clinically overt pancreatitis (Norsworthy *et al.* 2013). At present, it is unclear how to interpret such tests following surgical biopsy in clinical patients.

The aetiopathogenesis of postoperative pancreatitis has not yet been satisfactorily elucidated. Anecdotally, excessive manipulation of the pancreas ("surgical trauma") has been considered to increase the risk of pancreatitis. At the same time, careful but thorough palpation of the pancreas is recommended to localise lesions. There are currently no clear guidelines regarding how much manipulation is acceptable and at what stage excessive caution interferes with completeness of exploratory surgery. Five of the current cases had clinical signs suggestive of postoperative pancreatitis, with one case showing changes on abdominal ultrasound that supported this diagnosis. Another less well recognised but potential factor is that pancreatitis may occasionally develop following anaesthesia regardless of whether surgery is performed (Cook *et al.* 1993). Watson (2004) suggested hypotension-induced pancreatic ischaemia as a possible inciting cause for pancreatitis post anaesthesia. However, this was an un referenced

statement, and the available evidence documenting hypotension-induced pancreatitis in animals predominantly relates to experimental situations with severe induced hypotension (Mithöfer *et al.* 1995a, 1995b). In humans, ischaemic pancreatic damage from operative hypotension is generally only seen following very major surgeries such as organ transplantation and those requiring cardiopulmonary bypass (Londardo *et al.* 1999, Brülls *et al.* 2009).

It has been suggested that there is a higher risk of post-surgical acute pancreatitis in patients with pre-existing underlying inflammatory disease (Nelson & Couto 1998); however, robust clinical evidence to support this suggestion is lacking. In this study, 11 of 12 cats and 1 of 2 dogs diagnosed histologically with pre-existing pancreatitis had no postoperative complications recorded. This suggests a low incidence of post-surgical acute pancreatitis from exacerbation of underlying disease, particularly in cats.

This was a retrospective study, with all the inherent associated flaws. Data was collected retrospectively, so there was variability between cases in terms of underlying and concurrent diseases, clinical case management, surgical procedure(s) performed, the surgeon performing the procedures, pre and postoperative care provided and who performed the histopathological examination. The vagaries in diagnosis of pancreatitis have been previously discussed and the clinical pathology tests available for diagnosis of pancreatitis have changed over the time course of this study. The study was limited to events within the first 10 days of surgery, and therefore may have underestimated medium to long-term problems. Despite these limitations, however, there are some findings worthy of comment. Surgical biopsy of the pancreas is not without potential complications, but in these cases the only major complications appear most likely to have been caused by either suboptimal surgical technique (one case), other concurrent surgical procedures (one case) or the underlying disease (four cases). As such, there is no significant risk to surgical pancreatic biopsy per se provided good surgical technique and tissue handling are employed. It is common clinical practice to assume that a negative biopsy result, as seen in just over half of the current cases, means the patient is negative for pancreatic disease. However, on the basis of the available evidence it would be advisable to consider pancreatic biopsy findings in light of the overall clinical picture and other diagnostic tests. Surgeons should also consider whether a single biopsy sample taken from a randomly selected area of the pancreas in the absence of any grossly identifiable

abnormalities is warranted. Subjective assessment at the time of surgery that the pancreas was grossly unremarkable in these cases correlated reliably with a negative histology or finding of only BNH. While it should be taken into account that these cases were all operated within a referral environment by experienced surgeons, it suggests that there is a role for good surgical judgement when deciding whether to biopsy the pancreas.

Conflict of interest

None of the authors of this article has a financial or personal relationship with other people or organisations that could inappropriately influence or bias the content of the paper.

References

- Allen, S. W., Cornelius, L. M. & Mahaffey, E. A. (1989) A Comparison of two methods of partial pancreatectomy in the dog. *Veterinary Surgery* **18**, 274-278
- Barnes, R. F., Greenfield, C. L., Schaeffer, D. J., et al. (2006) Comparison of biopsy samples obtained using standard endoscopic instruments and the harmonic scalpel during laparoscopic and laparoscopic-assisted surgery in normal dogs. *Veterinary Surgery* **35**, 243-251
- Brülls, C. S., Dembinski, R., Jacobs, M. J., et al. (2009) Fatal necrotic pancreatitis as a rare complication after thoracoabdominal aortic surgery. *Journal of Cardiovascular and Thoracic Anesthesia* **23**, 926-929
- Chang, K. J., Nguyen, P., Erickson, R. A., et al. (1997) The clinical utility of endoscopic ultrasound-guided fine-needle aspiration in the diagnosis and staging of pancreatic carcinoma. *Gastrointestinal Endoscopy* **45**, 387-93
- Cook, A. K., Breitschwerdt, E. B., Levine, J. F., et al. (1993) Risk factors associated with acute pancreatitis in dogs: 101 cases (1985-1990). *Journal of the American Veterinary Medical Association* **203**, 673-679
- Cordner, A. P., Armstrong, J., Newman, S. J., et al. (2010) Effect of pancreatic tissue handling on serum pancreatic enzyme levels in clinically healthy dogs. *Journal of Veterinary Diagnostic Investigations* **22**, 702-707
- Cornell, K. (2012) Pancreas. In: *Veterinary Surgery Small Animal*. Vol 2 1st edn. Ed K. Tobias, S. A. Johnston. Elsevier Saunders, St Louis, MO, USA. pp 1659-1673
- Cornell, K. & Fischer, J. (2003) Surgery of the exocrine pancreas. In: *Textbook of Small Animal Surgery*. Vol 1 3rd edn. Ed D. Slatter. Saunders, Philadelphia, PA, USA. pp 752-762
- Cosford, K. L., Shmon, C. L., Myers, S. L., et al. (2010) Prospective evaluation of laparoscopic pancreatic biopsies in 11 healthy cats. *Journal of Veterinary Internal Medicine* **24**, 104-113
- De Cock, H. E. V., Forman, M. A., Farver, T. B., et al. (2007) Prevalence and histopathologic characteristics of pancreatitis in cats. *Veterinary Pathology* **44**, 39-49
- Dunn, J. K., Bostock, D. E., Herrtage, M. E., et al. (1993) Insulin-secreting tumours of the canine pancreas: clinical and pathological features of 11 cases. *Journal of Small Animal Practice* **34**, 325-331
- Etemad, B. & Whitcomb, D. C. (2001) Chronic pancreatitis: diagnosis, classification, and new genetic developments. *Gastroenterology* **120**, 682-707
- Forman, M. A., Shiroma, J., Armstrong, P. J., et al. (2009) Evaluation of feline pancreas-specific lipase (Spec fPL) for the diagnosis of feline pancreatitis. *Journal of Veterinary Internal Medicine* **23**, 733-734
- Gaschen, L., Kircher, P. & Lang, J. (2003) Endoscopic ultrasound instrumentation, applications in humans, and potential veterinary applications. *Veterinary Radiology and Ultrasound* **44**, 665-680
- Hassan, M. K. & Hawes, R. H. (2012) EUS-guided FNA of solid pancreas tumors. *Gastrointestinal Endoscopy Clinics of North America* **22**, 155-167
- Lightwood, R., Reber, H. A. & Way, L. W. (1976) The risk and accuracy of pancreatic biopsy. *The American Journal of Surgery* **132**, 189-194
- Lonardo, A., Grisendi, A., Bonilauri, S., et al. (1999) Ischaemic necrotizing pancreatitis after cardiac surgery. A case report and review of the literature. *Italian Journal of Gastroenterology and Hepatology* **31**, 872-875
- Lutz, T. A., Rand, J. S., Watt, P., et al. (1994) Pancreatic biopsy in normal cats. *Australian Veterinary Journal* **71**, 223-225
- McCord, K., Morley, P. S., Armstrong, J., et al. (2012) A multi-institutional study evaluating the diagnostic utility of the Spec cPL and SNAP Cpl in clinical acute pancreatitis in 84 dogs. *Journal of Veterinary Internal Medicine* **26**, 888-896
- Mehlhoff, C. J., Peterson, M. E., Patnaik, A. K., et al. (1985) Insulin-producing islet cell neoplasms: surgical considerations and general management in 35 dogs. *Journal of the American Animal Hospital Association* **21**, 607-612
- Mithöfer, K., Warshaw, A. L., Frick, T. W., et al. (1995a) Calcium administration augments pancreatic injury and ectopic trypsinogen activation after temporary systemic hypotension in rats. *Anesthesiology* **83**, 1266-1273
- Mithöfer, K., Fernández-del Castillo, C., Frick, T. W., et al. (1995b) Increased intrapancreatic trypsinogen activation in ischemia-induced experimental pancreatitis. *Annals of Surgery* **221**, 364-371
- Nelson, R. W. & Couto, G. C. (1998) The exocrine pancreas. In: *Small Animal Internal Medicine*. 2nd edn. Mosby, St. Louis, MO, USA. pp 555-570
- Newman, S., Steiner, J., Woosley, K., et al. (2004) Localization of pancreatic inflammation and necrosis in dogs. *Journal of Veterinary Internal Medicine* **18**, 488-493
- Newman, S. J., Steiner, J. M., Woosley, K., et al. (2005) Correlation of age and incidence of pancreatic exocrine nodular hyperplasia in the dog. *Veterinary Pathology* **42**, 510-513
- Norsworthy, G. D., Suchodolski, J. S. & Steiner, J. M. (2013) Effect of pancreatic biopsy on serum concentrations of feline pancreatic lipase immunoreactivity. Proceedings of the American College of Veterinary Internal Medicine, Seattle, Washington, DC, USA, June 12-15.
- Polton, G. A., White, R. N., Brearley, M. J., et al. (2007) Improved survival in a retrospective cohort of 28 dogs with insulinoma. *Journal of Small Animal Practice* **3**, 151-156
- Schultz, N. J. & Sanders, R. J. (1963) Evaluation of pancreatic biopsy. *Annals of Surgery* **158**, 1053-1057
- Schweighauser, A., Gaschen, F., Steiner, J., et al. (2009) Evaluation of endosonography as a new diagnostic tool for feline pancreatitis. *Journal of Feline Medicine and Surgery* **11**, 492-498
- Steiner, J. (2010) Canine pancreatic disease. In: *Textbook of Veterinary Internal Medicine Vol 2*. Eds S. J. Ettinger and E. C. Feldman. Saunders Elsevier, St Louis, MO, USA. pp 1695-1704
- Tobin, R. L., Nelson, R. W., Lucroy, M. D., et al. (1999) Outcome of surgical versus medical treatment of dogs diagnosed with beta cell neoplasia: 39 cases (1990-1997). *Journal of the American Veterinary Medical Association* **215**, 226-230
- Vazquez-Sequeiros, E. (2007) Endoscopic ultrasound and fine needle aspiration in inflammatory and cystic pancreatic pathology. *Minerva Medica* **98**, 357-360
- Washabau, R. J. (2010) Feline pancreatic disease. In: *Textbook of Veterinary Internal Medicine*. Vol 2. Eds S. J. Ettinger and Feldman. Saunders Elsevier, St Louis, MO, USA. pp 1704-1711
- Watson, P. (2004) Pancreatitis in the dog: dealing with a spectrum of disease. *In Practice* **26**, 64-77
- Watson, P. J., Roulois, A. J. A., Scase, T., et al. (2007) Prevalence and breed distribution of chronic pancreatitis at post-mortem examination in first opinion dogs. *Journal of Small Animal Practice* **11**, 609-618
- Webb, C. B. & Trott, C. (2008) Laparoscopic diagnosis of pancreatic disease in dogs and cats. *Journal of Veterinary Internal Medicine* **22**, 1263-1266