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ORIGINAL ARTICLE

Comparison of laparoscopic-assisted technique and open laparotomy for gastrointestinal biopsy in cats*

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Abstract

Objective: To evaluate and compare the complications, postoperative pain, surgical time, hospitalization time, and adequacy of biopsy specimens between laparoscopic assisted (LAP) versus open laparotomy (OPEN) gastrointestinal biopsies in cats.

Study Design: Prospective randomized clinical study.

Sample Population: Twenty-eight cats with clinical and ultrasonographic evidence of gastrointestinal disease. Fifteen cats in the LAP group and 13 in the OPEN group.

Methods: Signalment, presenting clinical signs, total duration of surgery, operative time, ease of procedure, incision length, postoperative pain scores, complications, and duration of hospitalization were recorded. Quality of gastrointestinal biopsies was compared between techniques.

Results: There was no difference in frequency of intraoperative complications ($P = .778$), surgical duration ($P = .333$), postoperative complications ($P = .722$), or duration of hospitalization ($P = .728$). Pain scores assigned before ($P = .198$) or 1 hour after surgery ($P = .073$) did not differ between groups; however, pain scores were lower at 6 hours ($P = .003$), 12 hours ($P = .001$), and 24 hours ($P = .005$) postoperatively in the LAP group. All cases survived surgery, with one case requiring conversion, and diagnostic biopsies were obtained in all cases.

Conclusion: Laparoscopic-assisted gastrointestinal biopsy technique provided diagnostic specimens and decreased postoperative pain compared to open surgical techniques. No difference was detected in surgical duration, complications, or duration of hospitalization.

1 | INTRODUCTION

Acquiring gastrointestinal biopsies is commonly performed to identify the cause of clinical signs of gastrointestinal disease (including weight loss, anorexia, vomiting, diarrhea, and thickened intestinal wall). Such signs are common in cats and intestinal biopsies are often necessary to differentiate inflammatory from neoplastic disorders.[1] Controversy remains regarding the relative value of partial thickness endoscopic biopsy or full thickness samples, but surgical samples have been shown valuable to establish a definitive diagnosis.[2] Laparoscopic-assisted gastrointestinal biopsy techniques are feasible in cats.[3] However, laparoscopic procedures are not routinely employed by veterinarians, in part because of the surgical expertise required, as well as the complexity and expense of the laparoscopic equipment. Additionally, concerns over the small size of cats may dissuade practitioners to recommend minimally invasive

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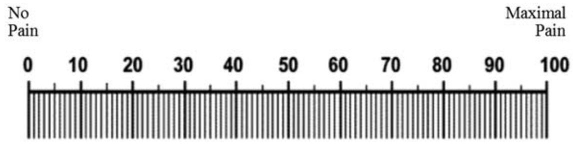
techniques. Furthermore, the potential for prolonged duration of surgery may make laparoscopic procedures less attractive in the typical practice setting.

Laparoscopic-assisted procedures maintain advantages of minimally invasive approaches while facilitating complex procedures by use of extracorporeal maneuvers, thereby reducing surgery time. Reduced pain has been reported with laparoscopic ovariectomy as well as laparoscopic-assisted ovariohysterectomy compared to open procedures in cats.[4-6] Additionally, the human and animal literature report faster resolution of postoperative ileus and fewer complications after laparoscopic compared to open gastrointestinal surgery.[7-11] Complications such as bleeding or organ laceration are rare during laparoscopy and can be minimized through proper surgical training.[12,13] Minimally invasive procedures have been effectively performed in cats and dogs of all sizes. In man, the costs of laparoscopic procedures are negated by shortened hospitalization and reduction in complications.[14,15]

To the authors' knowledge, no prospective study is available to establish the proposed superiority of laparoscopic-assisted (LAP) compared to open laparotomy (OPEN) gastrointestinal biopsies in cats. This randomized prospective clinical study was therefore designed to compare outcomes and quality of gastrointestinal biopsies in cats with gastrointestinal disease managed via laparoscopic-assisted versus open surgery.

We hypothesized that laparoscopic-assisted surgery would provide adequate gastrointestinal biopsies, and would be associated with longer surgical duration, shorter surgical incisions, and decreased postoperative pain compared to laparotomy in cats with evidence of gastrointestinal disease. We further hypothesized that there would be fewer intraoperative complications, postoperative complications, and shorter length of hospitalization in the LAP group when compared to the OPEN group.



Criteria used for pain scores; patients with VAS scores >50 were given additional opiods:

Minimal to Maximal Pain:
Avoidance of eye contact 10
Reluctance to stretch or lay laterally 20
Hunched or retracted posture 30
Withdraws when approached 40
Salivation 50
Dilated pupils 60
Vocalization 70
Growls or hisses when approached 80
Attacks when approached 90
Rigid and non-responsive 100

Observer approaches:
Approaches observer 0
Does not approach observer but raised head 20
No movement 40
Withdrawal of head or body 60
Avoidance; stands up to move away 80

Back is stroked:
Does not approach observer but raises head and arches back 0
No movement 25
Withdraws head or body 50
Avoidance; stands up to move away 75

Response to foot palpation:
Approaches observer 0
No response 25
Withdrawal of foot 50
Violent avoidance or struggle 75

Wound palpation:
No wound tenderness 0
Cat looking towards the incision in response to palpation 25
Evading behavior 75
Hissing/biting in response to wound palpation 100

FIGURE 1 Visual analog scale (VAS) used to score pain scoring. A single mark was made along the scale for each patient at each time period

2 | MATERIALS AND METHODS

The study was conducted and approved by the institutional animal care and use committee of our institution. Informed owner consent was obtained prior to inclusion into the study. Twenty-eight cats with clinical signs of gastrointestinal disease (weight loss, anorexia, vomiting, diarrhea) and intestinal abnormalities on abdominal ultrasonography (thickened intestinal wall with normal/abnormal layering) were randomly allocated to either OPEN or LAP groups using a coin toss method. Cats of any age, breed, gender, and body weight requiring gastrointestinal biopsies for diagnosis of suspected intestinal disease were included; preoperative treatment was recorded. Any animal with intraoperative evidence of peritonitis or abdominal masses was excluded from the study.

Signalment, body weight, and pertinent medical history were recorded in all cats. Physical evaluation and vital parameters were assessed prior to surgery. Preoperative complete blood count, serum biochemical profile, serum electrolyte concentration, coagulation panel, thoracic radiographs, and abdominal ultrasonography were performed. A preoperative baseline pain score using the visual analog scale (VAS) (Figure 1) was recorded prior to any preanesthesia medications.

2.1 | Anesthesia

Cats were premedicated with buprenorphine 0.01 mg/kg, intramuscular (Buprenex; Reckitt Benckiser Pharmaceuticals, Richmond, Virginia). General anesthesia was induced with propofol, 3 mg/kg, intravenous (IV) (Propoflo; Abbott Laboratories, North Chicago, Illinois) and diazepam 0.1 mg/kg, IV (Diazepam; Hospira, Lake Forest, Illinois), and maintained with isoflurane mixed with oxygen via endotracheal intubation. Continuous electrocardiography; systolic, diastolic, and mean arterial pressures; heart and respiratory rates; end-tidal carbon dioxide (CO_2); and pulse oximetry (SpO_2) were monitored and recorded during the duration of the anesthesia. Each cat was given perioperative antibiotics (cefazolin, 22 mg/kg IV) immediately after induction and then every 90 minutes thereafter until the end of surgery. Lactated Ringer's solution was administered during surgery (10 mL/kg/h IV). Total anesthesia time for both groups was recorded from time of induction and intubation to time the vaporizer was set at 0% at the end of the procedure.

2.2 | Surgical procedures

All surgeries were performed by 1 ACVS board certified surgeon (JKM). Cats in the LAP group were placed in dorsal recumbency. Pneumoperitoneum was attained in a standard fashion with the modified Hasson technique.[12,13] A 6-mm primary ribbed cone instrument port with suture fixation discs (Ribbed Cone, 6 mm; Karl Storz, Tuttlingen, Germany) was placed 2-3 cm caudal to the umbilicus on ventral midline. Traction sutures were positioned on either side of the linea alba and tied around the fixation disks and a 6-mm trocar cannula was placed through the instrument portal (6-mm trocar cannula, Karl Storz). The peritoneal cavity was distended using CO_2 and a mechanical insufflator to a pressure not in excess of 12 mm Hg (Insufflator; Stryker Endoscopy, Santa Clara, California). A 5-mm 0-degree rigid operative telescope (Hopkins II Telescope; Karl Storz), connected to camera and monitor, was introduced through the cannula for examination of the abdomen. The abdominal cavity was first evaluated for mass lesions or evidence of peritonitis. A ventral midline 6-mm trocar cannula 4-5 cm cranial to the primary trocar cannula without ribbed cone was placed to insert instruments and exteriorize bowel. After insertion of this cranial instrument portal, liver biopsies were obtained from the periphery and center of several liver lobes with 5-mm laparoscopic cup biopsy forceps (Clickline Biopsy Forceps; Karl Storz) as previously described.[16] Laparoscopic atraumatic grasping forceps (Clickline Dissecting and Grasping Forceps, atraumatic; Karl Storz) were used to grasp and exteriorize a small portion of the stomach fundus with removal of the cranial cannula. A 3-0 stay suture (PDS; Ethicon, Johnson & Johnson Gateway, Piscataway, New Jersey) was placed in the stomach. Extracorporeal, full thickness stomach biopsy was performed with #15 scalpel blade and Metzenbaum scissors. The site was closed with 3-0 PDS in a continuous appositional followed by continuous inverting pattern. The stomach was lavaged locally with normal saline (0.9% NaCl) solution and replaced into the abdomen. The trocar cannula was then replaced and a pneumoperitoneum was reintroduced. The atraumatic forceps were used to exteriorize the duodenum. Access to the duodenum was facilitated by rotation of the patient toward left lateral recumbency which allowed identification of the proximal duodenum. After extension of the cranial portal site by 1-2 cm in a cranial direction, the entire intestinal tract was gently exteriorized and fully examined. Gentle traction on the duodenal colic ligament was often needed to facilitate exposure. Evaluation of the entire small intestine, pancreas, and mesenteric lymph nodes was performed and extracorporeal duodenal, jejunal, and ilial biopsies were performed using #15 scalpel blade and Metzenbaum scissors. The intestinal biopsy sites were closed with 4-0 PDS in a simple interrupted appositional suture pattern, assessed for leakage, and lavaged locally with normal saline (0.9% NaCl) solution before replacement into the peritoneal cavity. Biopsy of any other abnormal pathology (including lymph nodes or pancreas) or additional procedures performed were recorded. Prior to closure, laparoscopic visualization of the abdomen was performed to inspect for hemorrhage or entrapment of regional tissue. This was facilitated by gently covering the cranial portal site to maintain a pneumoperitoneum. The abdomen was then evacuated of CO_2 gas and the 2 trocar sites were then closed routinely in 3 layers (ie, body wall, subcutaneous tissue, and skin). No skin sutures were placed unless intradermal closure was considered unacceptable. Topical tissue adhesive (GLUture, Zoetis, Kalamazoo, Michigan) was used as needed to address minor skin gaps. A single thin opaque bandage was placed over both trocar site (Tegaderm +Pad Film Dressing with Non-adherent Pad, 3M, St. Paul, Minnesota).

Cats allocated to the OPEN group were placed in dorsal recumbency. The abdomen was explored via ventral median celiotomy. Liver biopsies were obtained using the guillotine method with a 3-0 PDS simple interrupted crushing suture. Stomach and intestinal biopsy techniques were similar to those described above. Biopsy of any other abnormal pathology or additional procedures performed was recorded. The abdomen was lavaged with normal saline (0.9% NaCl) solution and inspected for hemorrhage prior to abdominal closure. The 3-layer closure and bandaging technique were similar to that described for the LAP group.

2.3 | Intraoperative evaluation

Total operating room time (from patient draping to completion of skin closure), surgical time (from initiation of first incision to end of incision closure), additional surgical procedures, incision lengths, need for conversion to open laparotomy with reason (LAP group), and complications were recorded. Potential intraoperative complications included anesthetic complications (hypotension, hypoventilation, cardiovascular compromise), laparoscopic equipment malfunction or loss of insufflation, excessive hemorrhage, penetration of hollow viscous, or organ/vessel laceration. Ease of the procedure was evaluated subjectively (ie, easy, moderate, difficult) by the operating surgeon. Intraoperative blood loss secondary to the biopsies was subjectively estimated by the surgeon and also recorded by quantifying the volume obtained by suction aspiration if occurred.

2.4 | Postoperative evaluation

The length of each surgical wound was measured in centimeter; for the LAP group, the length of the 2 incisions was added. Wounds were covered with a composite dressing bandage (3M Tegaderm +Pad, 3.5 × 8-inch transparent dressing with 1.75 × 6-inch nonadherent pad, 3M) to ensure that the investigator scoring postoperative pain would be unaware of group assignment. The bandage was changed at 12 and 24 hours postoperatively by the nursing staff to allow scoring of the incision.

After surgery, buprenorphine (0.01 mg/kg, IV) was administered to all cats immediately following extubation. Parenteral opioids (buprenorphine 0.01 mg/kg, IV) were administered every 6 hours for the first 24 hours followed by enteral opioids (buprenorphine 0.01 mg/kg, sublingually) every 8 hours for the next 3 days as needed based on pain scoring. Postoperatively, cats were administered fluid therapy with crystalloids and/or colloids at the discretion of the primary clinician. All cats were hospitalized for a minimum of 24 hours postoperatively to monitor postoperative stability. Vital parameters (hydration status, mucous membrane color, capillary refill time, heart rate, respiratory rate/effort, rectal temperature) were recorded every 6 hours postoperatively. Duration of hospitalization was compared. Postoperative complications were recorded, including bleeding (decrease in PCV compared to preoperative value), wound healing/complications (wound score; incisional infection, dehiscence, seroma, or herniation), pancreatitis (documented via abdominal ultrasound), and intestinal biopsy site dehiscence. Intestinal biopsy site dehiscence was suspected if there was cytological evidence of intracellular bacteria in abdominal effusion.

Wounds were scored[17] at 0, 12, and 24 hours, as well as 10 and 14 days after surgery with a standardized VAS. Major wound complications were defined as incisional abscess formation or need for revision surgery. Minor wound complications were defined as erythema, cellulitis, or discharge from the incision. Minor wound complications were assigned a severity score, classified as mild (grade 1), moderate (grade 2), or severe (grade 3). Focal regions of erythema and cellulitis were considered mild changes, whereas redness or swelling extending the full length of the incision was considered severe. Likewise, intermittent serosanguinous fluid production and discharge from the incision were considered mild, whereas continuous drainage was considered severe. The daily postoperative wound scores were added and analyzed.

Postoperative pain was assessed with the VAS (Figure 1).[18-21] All in-hospital pain observations were made by the same 2 observers (RC) and (PP) unaware of the surgical treatment group. Observers were surgical residents that overlapped to provide continuity and consistency of scoring methods. A single observer was assigned to each patient. VAS scores for pain were obtained preoperatively (prior to premedication) and at 1, 6, 12, and 24 hours after the end of surgery. The VAS scores were marked on 100 mm lines on which 0 corresponded to no pain, and 100 corresponded to maximal pain. The cats were initially examined through the bars of the cage, observing their posture, and assessing their response to vocal interaction. The cage door was then opened and the cat's interactions (calling cat to front of cage, noting demeanor, and willingness to move/interact, noting vocalization—purr/hiss/cry, response to general stroking and handling) were recorded. Response to wound palpation (looking toward the incision, to hissing, and trying to bite the observer) was also noted. The method for surgical site palpation was standard for all cats in the form of gentle digital palpation using the flat part of digits 2-4 of the observer's right hand. Palpation was performed 4 times immediately adjacent to the ventral abdominal midline but not directly over the incision.

If a cat appeared in unacceptable pain (VAS 50 or higher), intervention analgesia consisted of buprenorphine 0.01 mg/kg IV. The cat was reassessed 20 minutes later and received a second dose if indicated.

Gastrointestinal biopsy samples were submitted for histopathological analysis. Quality of the biopsy was considered adequate if all layers of intestine were present and a histopathologic diagnosis was established based on the submitted specimens. Short- and long-term follow-up information was obtained by return visit or telephone contact with the referring veterinarian or client. Minimum follow-up was 10 days.

2.5 | Statistical analysis

Numerical variables were assessed for normal distribution with the Shapiro-Wilk test. Parametric data were summarized as mean and SD. Parametric groups were compared using the Student's *t* test with equal variances (total operating room time) or *t* test with unequal variances (surgical procedural time). The *F* test for homogeneity was used to assess equality of variances. Nonparametric data were summarized as median and interquartile range (IQR). Nonparametric groups of data (length of hospitalization, pain scores, and incision length) were compared using the Wilcoxon rank sum test. Proportions of categorical data (intraoperative complication rates and surgeon's assessment of ease of procedure) were compared using Fisher's exact test due to expected cell frequencies of less than 5. *P* values indicating an alpha error rate of less than .05 were considered statistically significant (STATA SE, v.14.1; State Corp, College Station, Texas).

3 | RESULTS

Our study enrolled 15 cats in the LAP group and 13 in the OPEN group. No animals were excluded due to peritonitis or abdominal masses. The majority of cats included in this study were Domestic Short Hair (n = 21 [75%]) and there were one each of Tonkinese, Somali, Domestic Medium Hair, Himalayan, Rex, Abyssian, and American Short Hair. The overall mean age was 11.4 years old (SD 3.4) with LAP average 11.4 years (SD 2.8) versus OPEN 11.5 years (SD 4.1). The population included 57% (16/28) spayed female cats and 42% (12/28) male castrated cats included; 6 spayed female cats were in the OPEN group and 10 were in the LAP group. There were 7 castrated males in the OPEN group and 5 in the LAP group. No intact cat was included in this study. The mean body weight was 4.01 kg (SD 0.95) with the average for the OPEN group 4.12 kg (SD 1.07) similar to the LAP group 3.93 kg (SD 0.85). Prior pertinent medical history for the LAP group included weight loss 12/15 (80%), vomiting 7/15 (47%), 7/15 (47%) diarrhea, and 7/15 (47%) decreased appetite. Prior pertinent medical history for the OPEN group included weight loss 11/13 (85%), vomiting 9/13 (69%), decreased appetite 8/13 (62%), and diarrhea 5/13 (38%). Duration of clinical signs prior to surgery did not differ between groups ($P = .210$), with a median of 150 days (IQR 30-485) in the LAP group and 44 days (IQR 7-165) in the OPEN group. Thickening of the intestine was seen on preoperative abdominal ultrasonography in all cases, while abnormal intestinal layering was present in 11/13 OPEN group cases and 11/15 in the LAP group. Abnormalities on preoperative bloodwork included anemia (3/15 LAP, 5/13 OPEN), azotemia (3/15 LAP, 1/13 OPEN), hypoproteinemia (0/15 LAP, 2/13 OPEN), and no coagulopathies in either group.

Intraoperative complications included hypotension (6 OPEN, 4 LAP), vessel laceration (1 OPEN), need for conversion to an open procedure due to concern for bleeding (1 LAP). The rates of intraoperative complications did not differ between groups ($P = .778$). Additional procedures were performed in 4/15 LAP and 6/13 OPEN procedures, and included esophageal feeding tube placement (4/28), endoscopy with biopsies (2/28), splenic biopsy (1/28), pancreatic biopsy (1/28), percutaneous endoscopic gastrostomy (PEG) tube placement (1/28), foreign body removal (1/28), and pancreatic cyst omentalization (1/28). Surgical times did not differ ($P = .333$) between laparoscopic-assisted biopsies (65.5 ± 26.4 minutes) and open biopsies (74.1 ± 11.7 minutes). No difference was found in total operating room time between groups (LAP 80.3 ± 13.4 minutes, OPEN 78.1 ± 20.1 minutes, $P = .726$). Surgeon's categorical assessment of the ease of procedure did not differ between the groups ($P = .696$).

There was only 1 minor wound complication in each group. Postoperative complications included septic abdomen due to feeding tube abscess (1 LAP), pancreatitis (1 OPEN), postoperative bleeding requiring transfusion (1 OPEN), and need for blood transfusion due to pre-existing anemia (1 LAP). Postoperative complications occurred in 2/15 cats of the LAP group and 2/13 cats in the OPEN group ($P = .722$). Duration of hospitalization was similar between the LAP group (median 36 hours, IQR 36-48 hours) and the OPEN group (median 36 hours, IQR 30-48 hours) ($P = .728$). The preoperative pain scores were similar ($P = .198$) between groups, with a median of 0 (IQR 0-0) in the each group. The 1-hour postoperative pain scores did not differ ($P = .073$), with median scores of 20 (IQR 20-30) and 40 (IQR 20-45), for the LAP and OPEN groups, respectively. The pain scores at 6 hours postoperative were lower in the LAP group (median: 10; IQR 10-20) than in the OPEN group (median: 30; IQR 20-40) ($P = .003$). They were also lower at 12 hours postoperative for the LAP group, median 10 (IQR 5-10) versus the OPEN group, median 30 (IQR 20-32) ($P = .001$) as well as at 24 hours postoperative, LAP median 10 (IQR 5-10) versus OPEN median 20 (IQR 10-25) ($P = .005$) (Figure 2). Surgical wounds in the OPEN group, median 11 cm (IQR 10-12.5), were longer than in the LAP group, median 4 cm (IQR 3-5) ($P < 0.001$). Diagnostic biopsies were obtained for all cases in both groups and included 15 cases of lymphoma (7 LAP, 8 OPEN), 10 cases of lymphoplasmacytic enteritis (8 LAP, 2 OPEN), 2 OPEN cases of normal intestines with tumor in other organs (mast cell tumor, pancreatic adenocarcinoma), and 1 OPEN case of normal intestines with lymphocytic cholangiohepatitis. There were no

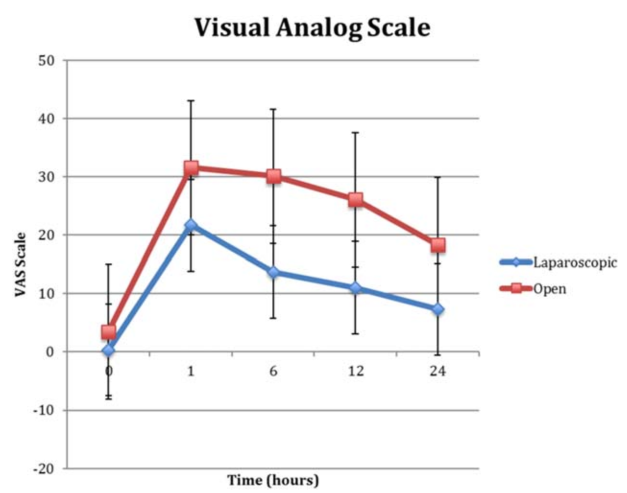


FIGURE 2 Comparison of median visual analog scale (VAS) pain scores in the LAP versus OPEN surgery group after surgery

procedural deaths and 82% of cases survived to 3 weeks postoperative, 2/15 LAP cases and 2/13 OPEN cases were euthanized within this time frame.

4 | DISCUSSION

Our study is the first prospective comparison of laparoscopic-assisted and open laparotomy gastrointestinal biopsies in cats. Quality of biopsy specimens, intraoperative and postoperative complications, and duration of hospitalization did not differ between techniques. Contrary to our hypothesis, duration of anesthesia and surgery were not prolonged by the laparoscopic procedure. However, postoperative pain scores were lower with this technique, confirming previous studies of minimally invasive surgery.[4,6,22] These lower scores have been attributed to the shorter surgical wound and reduced tissue trauma. Pain scores did not differ between LAP and OPEN groups at 1 hour, contrasting with prior studies where laparoscopy was associated with lower pain scores at all time points, including immediately after surgery.[4,6,22-24] This discrepancy may be due to administration of analgesics and initial postanesthetic dysphoria, which could have precluded objective assessment of pain. In man, pain after laparoscopy has been linked to the insufflation of CO_2,[25] due to increased intraabdominal pressure or desiccation of the peritoneal surface from nonhumidified insufflated gas. Such complication has not been supported in the veterinary literature.[26] A mild decrease in the peritoneal pH has been documented in dogs after laparoscopy,[27] and further study is needed to better understand the relationship between peritoneal acidosis and pain. Our initial lack of difference in pain scores between groups could be explained by a transient CO_2-induced peritoneal irritation or acidosis.

Pain assessment studies are challenged by the ability to avoid investigator's bias while scoring patients. In the present study, surgical sites were masked by bandages of similar lengths, replaced at standard intervals while in hospital. Bandage strike-through was not noted in our records, and it is therefore unlikely that this sign would have revealed group assignment during pain analysis. Two clinicians assessed pain via VAS over the course of the study. This semiobjective analysis may include inherent biases as it relies on an outside observer to appropriately identify and interpret a patient's pain. Therefore, variability between observers and patients is a real limitation, affecting the accuracy of interpretation of the individual cat's pain score. We attempted to address this limitation by masking the surgical group assignment and utilizing the same observer throughout hospitalization to reduce the variability among individual feline assessments. The temperament of cats can complicate pain scoring in cats precluding repeat examination. Other reported pain scoring methods include the use of accelerometer activity monitors,[28] the 4 A-Vet composite pain score,[4] the simple descriptive scale,[5,29] and pressure nociceptive devices.[5,30] A recent study has shown overall similarity between VAS, nociceptive, or other scoring methods in cats undergoing ovariectomy.[5]

Complications occurred in 7% of cats in our study, the most common involving wound healing (bruising, superficial infections) and postoperative blood transfusion. Although some studies have reported a higher rate of postoperative complications after laparoscopic compared to open surgery,[24] many report opposite findings, in response to reduced tissue handling, inflammation, and incision size.[31-33] No difference in postoperative complications was detected in our study, most likely because complications were uncommon in both groups. The mortality rate of cats in our study was low, with no intraoperative death, and 82% of cases surviving to 3 weeks after surgery. One cat with a PEG tube placed endoscopically after laparoscopy was suspected of developing a septic abdomen secondary to a PEG tube abscess 7 days after surgery, based on ultrasonographic examination. The owners elected euthanasia and postmortem examination was not allowed. Cause of death in the remaining cats was suspected to be secondary to metastatic disease or progressive worsening of pre-existing clinical signs.

One of the main limitations of this study is our small sample size and concurrent variables. A small, but equal number of patients had additional minor procedures performed at the time of biopsy. Ideally, biopsy alone could be studied in the future to isolate the complications and/or additional pain that may have been induced by these procedures. Additionally, modifications such as use of single port laparoscopy[5,34,35] or NOTES procedures[36] warrant future investigation as a biopsy technique. Finally, necropsy examination was not performed in deceased patients, preventing definitive diagnosis of the cause of death.

Minimally invasive procedures have become the gold standard in human medicine, an evolution that veterinary medicine is likely to follow. Veterinary surgery specialists perceive that these techniques lower postoperative morbidity and represent the highest patient standard of care.[37] Increasing awareness among animal owners makes these surgeries attractive alternatives to traditional open techniques.

5 | CONCLUSION AND CLINICAL RELEVANCE

Laparoscopic-assisted gastrointestinal biopsy technique provided diagnostic specimens and decreased postoperative pain compared to open surgical techniques. No difference was detected in surgical duration, complications, or duration of hospitalization. Laparoscopic-assisted biopsy provides an acceptable alternative to open laparotomy to acquire gastrointestinal tissue specimens in cats.

ACKNOWLEDGMENTS

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest related to this report.

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