Short-term clinical outcome of laparoscopic liver biopsy in dogs: 106 cases (2003–2013)

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OBJECTIVE
To describe the operative technique, complications, and conversion rates for laparoscopic liver biopsy (LLB) in dogs and evaluate short-term clinical outcome for dogs that underwent the procedure.

DESIGN
Retrospective case series.

ANIMALS
106 client-owned dogs.

PROCEDURES
Medical records were reviewed to identify dogs that underwent an LLB with a single-port or multiport technique at either of 2 veterinary teaching hospitals from August 2003 to September 2013. Demographic and laboratory data, preoperative administration of fresh frozen plasma, procedural and diagnostic information, intraoperative complications, and survival to discharge were recorded. The LLB specimens were obtained with 5-mm laparoscopic biopsy cup forceps and a grasp-and-twist technique.

RESULTS
Prior to surgery, 25 of 94 (27%) dogs had coagulopathy (prothrombin time or partial thromboplastin time greater than the facility reference ranges, regardless of platelet count). Twenty-one dogs were thrombocytopenic, 14 had ascites, and 14 received fresh frozen plasma transfusion before surgery. In all cases, biopsy samples collected were of sufficient size and quality for histopathologic evaluation. Two dogs required conversion to an open laparotomy because of splenic laceration during initial port placement. One hundred one of 106 dogs survived to discharge; 5 were euthanized during hospitalization owing to progression of liver disease and poor prognosis.

CONCLUSIONS AND CLINICAL RELEVANCE
Single-port and multiport LLB were found to be effective, minimally invasive diagnostic techniques with a low rate of complications. Results suggested LLB can be safely used in dogs with underlying coagulopathies and advanced liver disease. (J Am Vet Med Assoc 2016;248:83–90)
The LLB technique combines the benefits of minimally invasive surgery with the ability to collect a sample of liver parenchyma large enough for histologic evaluation at a grossly visualized, optimal location.14 With this laparoscopic technique, the region where the biopsy sample was obtained can be directly observed and evaluated for excessive hemorrhage immediately following collection.

Liver biopsies are not without risk and are commonly performed in debilitated patients with varying degrees of underlying hepatic disease. These underlying diseases may complicate the procedure itself as well as complicate immediate postoperative recovery. Risks inherent to liver biopsy include hypotension, uncontrolled hemorrhage, damage to adjacent viscera, peritonitis, or hepatic emphysema.1,15,16 Patients with advanced liver disease can have ascites, coagulopathies, or thrombocytopenia and may be at increased risk of complications and hemorrhage secondary to liver biopsy.1,15,17

Few reports exist detailing the complication and conversion rates of diagnostic laparoscopic procedures in companion animals. Reported conversion rates from laparoscopy to an open laparotomy following a diagnostic procedure in dogs and cats have been reported to be as high as 20 of 94 (21%).18 A recent study18 that evaluated an array of diagnostic laparoscopic procedures (including patients that underwent LLB) revealed a complication rate of 6 of 80 (7.5%). Both of these reports included patients that had undergone laparoscopic-assisted procedures in addition to the LLB, thus preventing a true evaluation of the safety and efficacy of LLB as a diagnostic technique. To the authors’ knowledge, currently there are no reports in the veterinary literature evaluating complications and conversion rates for LLB without other combined laparoscopic-assisted procedures. The purpose of the study reported here was to describe an LLB technique used in 2 large veterinary teaching hospitals, report on its intraoperative complication and conversion rates, and assess the short-term clinical outcome in dogs that underwent the procedure.

Materials and Methods

Case selection

Electronic and hard copy medical records of client-owned dogs that underwent single-port or multiport LLB between August 31, 2003, and September 1, 2013, at the Matthew J. Ryan Veterinary Hospital of the University of Pennsylvania and the William R. Pritchard Veterinary Medical Teaching Hospital at the University of California-Davis School of Veterinary Medicine were reviewed to identify dogs that underwent LLB. Dogs were excluded if the medical record was incomplete or if the patient had any laparoscopic-assisted procedure performed concurrently. Dogs that had an additional completely laparoscopic procedure (such as a laparoscopic ovariectomy) or an extraabdominal surgical procedure were included.

Medical records review

Demographic information for dogs, including signalment and body condition score determined with a standardized scoring system19 (from 1 [very thin with no discernable body fat] to 9 [obese, with substantial fat deposits and clear abdominal distension]), were recorded. Preoperative laboratory data recorded included PT and PTT, with values greater than the hospital-specific reference range defined as indicative of coagulopathy. A platelet count was determined, with values less than the hospital-specific reference range defined as indicating thrombocytopenia. Any preoperative FFP transfusion was also recorded. Operative data collected included the number and type of laparoscopic ports, location of ports, presence of ascites, conversion to open laparotomy, and any fully laparoscopic or extraabdominal procedures that were performed concurrently. Intraoperative complications were considered to have occurred if any adverse intraoperative event was recorded in the surgical procedure report, patient record, or discharge summary (eg, uncontrolled hemorrhage, damage to adjacent viscera, or conversion of the procedure to an open laparotomy). The histologic report was reviewed to determine whether an adequate diagnostic sample was obtained. Hospitalization time, defined as the time associated with the LLB procedure from admission to discharge, and survival to discharge were also recorded.

Anesthetic and analgesic protocol

Dogs were premedicated according to a protocol determined for each patient individually and approved by the hospital anesthesiologist. General anesthesia was induced with an agent approved by the attending anesthesiologist overseeing the case up to the time of intubation. General anesthesia was maintained with isoflurane or sevoflurane in oxygen, administered to effect. All anesthetic and analgesic medications administered were selected according to the preferences of the attending anesthesiologist.

Surgical technique

The surgical field was prepared by clipping hair from the ventral aspect of the abdomen extending from the xiphoid process to pubis. All dogs were placed in dorsal recumbency on a mechanical tilt table.4 The ventral abdominal region was aseptically prepared and draped as for a traditional open abdominal procedure to allow for the placement of additional trocar-cannula assemblies or for conversion to open surgery if deemed necessary. The decision to perform a single- or multiport procedure was made according to the preference of the primary surgeon. Both single-port and multiport procedures were commonly performed at participating hospitals by surgeons or residents trained in these techniques. Treatment of all dogs was according to current accepted standards of care.

Multiport laparoscopic technique

A 0.5-cm incision was created at the umbilicus or immediately caudal to this location to allow for place-
ment of the initial port. A modified Hasson technique was used to introduce a 6-mm trocar-cannula assembly for placement of a 5-mm 0° or 30° telescope. Insufflator tubing was then attached, and the abdomen was insufflated to 8 to 10 mm Hg with carbon dioxide by means of a pressure-regulating mechanical insufflator. A second 6-mm trocar-cannula assembly was then placed 3 to 5 cm lateral to the ventral midline in the left or right cranial abdominal quadrant. This trocar-cannula assembly was inserted percutaneously with the aid of a sharp obturator or with a threaded screw-in tip port under direct laparoscopic guidance (Figure 1).

**Single-port laparoscopic technique**

For patients that had a single-port LLB, a 2-cm incision was made through the skin at the level of the umbilicus with a combination of sharp dissection and electrocautery. This incision was extended through the subcutaneous tissues and into the peritoneal cavity. The single-port multitrocar device was inserted as previously described. Briefly, a small amount of sterile lubricant was applied to the base of the multitrocar device, which was then inserted into the abdominal incision by clamping 2 curved Rochester-Carmalt forceps at its base in a staggered fashion and directing the leading tip into the abdominal incision. Three 5-mm cannulae (supplied with the port) were then inserted into the 3 corresponding cannula holes of the device with the aid of an accompanying 5-mm blunt obturator. Heights of the cannulae were then staggered, insufflator tubing was attached, and the abdomen was insufflated to 8 to 10 mm Hg with carbon dioxide through use of a pressure regulating mechanical insufflator. Arrangement of instruments through the cannulae is illustrated (Figure 2).

**LLB technique**

A 5-mm 0° or 30° telescope was inserted into the abdomen, and a visual abdominal exploratory evaluation was performed prior to collection of any biopsy samples. The presence of ascites, the appearance of the liver, and any other gross abnormalities in the abdomen were noted. A 5-mm blunt laparoscopic probe was introduced into the abdomen and used to lift and manipulate the liver lobes so that the surface of each lobe was visualized and examined. When patient conformation or anatomy prevented adequate visualization, the mechanical table was used to tilt the patient laterally to the right or left and in Trendelenburg or reverse Trendelenburg position to enable complete visual examination of the liver. At least 3 to 5 biopsy samples in total were then collected from multiple liver lobes with 5-mm biopsy cup forceps. Samples were collected from the periphery of various liver lobes as indicated by presence and location of diseased tissue or a region of interest. Sample collection was performed by grasping the hepatic tissue with the forceps and then twisting in a clockwise direction for 4 to 6 full revolutions on the instrument’s shaft axis (Figure 3). The surgeon maintained steady, gentle traction until the specimen was free from the remaining liver parenchyma. When the lesion was centralized within the liver lobe and this was the only region on the lobe that had pathological features, the biopsy cup forceps was opened fully and advanced onto the center of the lesion, or the edge of the lesion was biopsied at its junction adjacent to normal-appearing parenchyma. The same twisting technique was then used and gentle traction applied for removal of the biopsy specimen. All collection sites were visually examined to ensure adequate hemostasis. Additional laparoscop-
Coagulopathy was defined as PT or PTT prolongation of 0.0% prolonged. Coagulopathy was defined as PT or PTT prolongation of 0.0%, irrespective of platelet count. Differences in reference ranges between test laboratories, percentage prolongation of PT and PTT was calculated according to the following formula: (test value - upper limit of reference range)/upper limit of reference range. Test values that fell within the respective reference range were considered 0.0% prolonged. Coagulopathy was defined as PT or PTT prolongation > 0.0%, irrespective of platelet count.

Descriptive statistics were calculated for recorded variables. Categorical variables were expressed as numbers and percentages. Continuous variables were assessed for normal distribution by use of quantile-quantile plots and tests of skewness and kurtosis. When normality was confirmed, data were expressed as mean and SD; otherwise, median and range values were reported. To account for differences in reference ranges between test laboratories, percentage prolongation of PT and PTT was calculated according to the following formula: (test value - upper limit of reference range)/upper limit of reference range. Test values that fell within the respective facility’s reference range were considered 0.0% prolonged. Coagulopathy was defined as PT or PTT prolongation > 0.0%, irrespective of platelet count. Logistic regression analysis was performed with occurrence of an intraoperative complication used as the dependent variable and age, sex, body weight, percent prolongation of preoperative PT, percent prolongation of preoperative PTT, and preoperative platelet count as independent variables. A forward selection model was planned, testing covariates with Wald \( P < 0.05 \) on univariate analyses in a multivariate model; however, none of the covariates were significantly associated with intraoperative complication at the \( P < 0.05 \) level. Proportions of dogs in the study population with and without coagulopathy that received an FFP transfusion were compared by means of the Fisher exact test. For the subset of dogs with coagulopathy, the Wilcoxon rank sum test was used to compare PT prolongation, PTT prolongation, and platelet counts between dogs that did and did not receive a preoperative FFP transfusion. Computer software\(^b\) was used to perform statistical tests. All tests were 2-sided, and \( P < 0.05 \) was considered significant.

**Results**

In total, 106 dogs met the study inclusion criteria. Mixed-breed dogs (\( n = 29 \)) and Labrador Retriever (16) were most commonly represented. Other breeds included Siberian Husky (\( n = 5 \)); Golden Retriever, Shih Tzu, and Maltese (4 each); Doberman Pinscher, German Shepherd Dog, and Jack Russell Terrier (3 each); Chihuahua, Cairn Terrier, Great Dane, Miniature Dachshund, Standard Poodle, Toy Poodle, and West Highland White Terrier (2 each); and Australian Shepherd, Basset Hound, Bichon Frise, English Bulldog, Chinese Crested, Clumber Spaniel, Cock-er Spaniel, Dandie Dinmont Terrier, English Springer Spaniel, German Shorthaired Pointer, Havanese, Keeshond, Miniature Pinscher, Norfolk Terrier, Pug, Pembroke Welsh Corgi, Rottweiler, Samoyed, Shar-Pei, and Viszla (1 each).

Median age was 84 months (range, 5 to 180 months), median weight was 22.4 kg (49.3 lb; range, 2.5 to 58.2 kg [5.5 to 128.0 lb]), and median body condition score was 5 (range, 2 to 8). Fifty-nine dogs were female (54 spayed and 5 sexually intact) and 47 were male (39 castrated and 8 sexually intact).

Coagulation profiles that included PT, PTT, and platelet counts were reported for 94 dogs. Platelet clumping precluded automated counts for 10 dogs, but manual review of a blood smear indicated adequate platelet numbers. Among the remaining 84 dogs, 21 (25.0%) were thrombocytopenic (having < 178,000 platelets/µL or < 150,000 platelets/µL at the University of Pennsylvania or University of California-Davis facilities, respectively), with a median count of 143,000 platelets/µL (range, 41,000 to 175,000 platelets/µL). Overall, 25 of 94 (26.6%) dogs were classified as coagulopathic. The PT was prolonged by a median of 15.7% (range, 3.2% to 87.3%) in 24 dogs, and PTT was prolonged by a median of 60.0% (range, 1.2% to 36.6%) in 12 dogs. No dogs had PT or PTT results below the respective reference ranges.

Preoperative FFP transfusions were administered to 14 dogs, 10 of which were coagulopathic. Among the other 4 dogs, 2 had PT and PTT within the respective reference ranges but had moderate thrombocytopenia (41,000/µL and 84,000/µL), and 2 had PT, PTT, and platelet counts within the respective reference ranges. Coagulopathic dogs were significantly (\( P < 0.001 \)) more likely to receive FFP than were dogs without coagulopathy (15/25 [60%] vs 4/69 [6%], respectively). Furthermore, coagulopathic dogs that received FFP had a significantly greater percentage prolongation of PTT and a significantly lower platelet count, compared with results for those that did not receive FFP (Table 1). No

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**Table 1**

<table>
<thead>
<tr>
<th>Coagulation Profile</th>
<th>No Coagulopathy</th>
<th>Coagulopathy</th>
</tr>
</thead>
<tbody>
<tr>
<td>PT prolongation</td>
<td>0.0%</td>
<td>15.7%</td>
</tr>
<tr>
<td>PTT prolongation</td>
<td>0.0%</td>
<td>60.0%</td>
</tr>
<tr>
<td>Platelet count</td>
<td>143,000/µL</td>
<td>41,000/µL</td>
</tr>
</tbody>
</table>

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**Figure 3**—Representative intraoperative photograph obtained during LLB. A biopsy cup forceps is used as a probe to examine both surfaces of the quadrate lobe in a 2-year-old neutered male Havanese.
dog with coagulopathy or thrombocytopenia had excessive hemorrhage associated with liver biopsy or required conversion to laparotomy.

**Surgical data**

The multiport laparoscopic technique was used in 99 cases, and the single-port technique was used in 7. Fourteen of 106 (13.2%) dogs were noted to have ascites present during the laparoscopic exploration; fluid was removed by suction prior to collecting biopsy samples. Conversion to an open celiotomy was required in only 2 of 106 (1.9%) dogs that underwent LLB. In both cases, the decision to convert was made because of hemorrhage (which could not be controlled laparoscopically) from a splenic capsular laceration that occurred during the initial trocar-cannula assembly placement. A multiport laparoscopic surgical approach had been used for both of these dogs. In both patients, hemostasis was achieved through application of digital pressure and suturing of the splenic capsule. Both dogs recovered uneventfully and were discharged from the hospital on the following day. No dogs required conversion because of complications directly related to the LLB procedure, and no other intraoperative complications were recorded. Intraoperative complications were not significantly associated with patient age (OR, 1.00; 95% CI, 0.97 to 1.04), male sex (OR, 1.26; 95% CI, 0.80 to 2.01), body weight (OR, 1.00; 95% CI, 0.91 to 1.11), PT (OR, 0.35; 95% CI, 0.05 to 2.60), PTT (OR, 0.14; 95% CI, 0.02 to 1.08), or platelet count (OR, 1.00; 95% CI, 0.98 to 1.01).

Additional laparoscopic procedures performed included a kidney biopsy (n = 4), ovaricectomy (5), cholecystectomy (9), cholecystectomy (1), splenic aspiration (1), and pancreatic biopsy (1). Fourteen patients had an extra-abdominal procedure, including subcutaneous mass removal (n = 5), esophageal feeding tube placement (3), castration (2), parathyroidectomy (2), thyroidectomy (1), and a tibial tuberosity transposition and wedge trochleoplasty (1).

**Postoperative data and histologic assessments**

Of the 106 dogs, 101 (95.3%) survived to hospital discharge. The median total hospitalization time was 2 days (range, 1 to 11 days). Biopsy results for the 5 patients that did not survive to discharge revealed lobar dissecting hepatitis (n = 1), lymphosarcoma (1), histocytic sarcoma (1), severe chronic hepatitis with hepato-cellular necrosis (1), and massive hepatic necrosis (1). All 106 dogs had a sample collected that was of sufficient diagnostic quality for histologic evaluation.

**Discussion**

Results of the present study confirmed that LLB was a safe and effective minimally invasive technique for obtaining a histologic diagnosis of hepatic disease. In this study, LLB was performed for dogs of a wide range of sizes as well as in patients with clinical signs of advanced liver disease, such as coagulopathies, thrombocytopenia, and ascites. Intraoperative complications were rare (2/106 [1.9%]) and were associated with initial establishment of port access rather than biopsy specimen collection. These findings are relevant to companion animal surgery, considering that the accurate diagnosis of liver disease will affect recommended treatment protocols and patient prognosis.

Other commonly performed diagnostic techniques used in veterinary medicine for diagnosing liver disease include fine-needle aspiration, ultrasound-guided needle biopsy, and open laparotomy. Because many liver diseases cannot be surgically resolved, a minimally invasive approach, such as fine-needle aspiration or ultrasound-guided needle biopsy, is appealing to many practitioners because this potentially avoids the need for general anesthesia and a surgical procedure. Fine-needle aspiration is fast, is cost effective for the owner, requires minimal sedation, and has a low risk of hemorrhage because of the small needle size. However, this is a less accurate diagnostic test, as its agreement with a histopathologic diagnosis ranges from 30% to 50%. A sample of sufficient size for histologic evaluation can be collected by ultrasound-guided core-needle biopsy, and samples can be collected from multiple liver lobes using this method. It can be performed under heavy sedation, which may decrease cost to the owner, although general anesthesia may be required at some institutions or for some patients. The agreement of findings for needle biopsy versus wedge biopsy of the liver in dogs and cats has been evaluated, and investigators found that the morphologic diagnosis for specimens obtained by needle biopsy differed from that for the gold standard wedge tissue biopsy in 65 of 124 (52%) cases. Those authors speculated that inadequate tissue representation limited the accuracy of pathological interpretation, and this seemed to be related to the needle gauge that was used. Studies have previously shown that LLB can be used to collect a specimen of appropriate size and with enough portal triads available for histologic evaluation.

### Table 1—Median (range) preoperative coagulation variables for 25 dogs with coagulopathy undergoing LLB at 1 of 2 veterinary teaching hospitals, categorized according to whether FFP transfusion was performed prior to surgery.

<table>
<thead>
<tr>
<th>Variable</th>
<th>No FFP (n = 10)</th>
<th>FFP (n = 15)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PT (% prolongation)</td>
<td>24.5 (4.9–87.2)</td>
<td>12.7 (0.0–72.0)</td>
<td>0.165</td>
</tr>
<tr>
<td>PTT (% prolongation)</td>
<td>91 (0.0–36.6)</td>
<td>0.0 (0.0–36.4)</td>
<td>0.023</td>
</tr>
<tr>
<td>Platelets (X 10^3/µL)</td>
<td>144 (88–213)</td>
<td>223 (64–583)</td>
<td>0.035</td>
</tr>
</tbody>
</table>

To account for differences in reference ranges between test laboratories, percentage prolongation of PT and PTT was calculated according to the following formula: (test value – upper limit of reference range)/upper limit of reference range; test values that fell within reference range were considered 0.0% prolonged. No PT or PTT results fell below the reference ranges. Coagulopathy was defined as either PT or PTT prolongation > 0.0%, irrespective of platelet count. Values of P < 0.05 were considered significant.
Combining the benefits of a minimally invasive surgical approach with the ability to obtain an accurate diagnosis through collection of an appropriately sized tissue sample is an ideal approach for many patients, especially those that are debilitated because of underlying hepatic disease. The previously reported complication rates for laparoscopy in veterinary medicine are relatively high and may lead some clinicians to use other techniques that are potentially less effective or more invasive. Within our study, dogs that underwent LLB had lower complication and conversion rates than have previously been published in the veterinary literature. The patient population in our study was not censored and included a diverse group of dogs from 2 large veterinary teaching hospitals. This study population included patients with a variety of underlying hepatopathies as well as those with advanced signs of disease such as coagulopathies or ascites. Twenty-five patients were determined to have had a coagulopathy, and 10 of the 25 had received an FFP transfusion prior to the LLB. This was presumably intended to prevent bleeding owing to the decreased synthesis of coagulation factors and hypocoagulability associated with advanced liver disease. The decision to administer FFP was made at the discretion of the primary clinician overseeing the case. In human patients, abnormal coagulation test results do not necessarily predict bleeding among patients undergoing invasive procedures, including liver biopsy. Although FFP is effective for actively bleeding patients with coagulopathies, there is limited evidence in people or animals that FFP will prevent hemorrhage when administered prophylactically. It is also important to consider that FFP does not contain substantial numbers of platelets and is not indicated for the prevention or treatment of bleeding due to thrombocytopenia. In our study, all dogs with prolonged coagulation times had a successful procedure without complications, including several that did not receive FFP. However, there is confounding by indication because dogs with more severe coagulation alterations and thrombocytopenia were more likely to receive FFP than dogs without these conditions. Prophylactic FFP is not clearly indicated for nonbleeding dogs with mild to moderate PT or PTT prolongations prior to LLB. Future studies are needed to determine whether objective measurements can be used to guide clinicians in regard to indications for FFP administration. It is our recommendation that each case is approached with caution and that clinicians should use best available evidence when deciding whether or not to administer FFP prior to a liver biopsy, while recognizing the potential of adverse events and increased cost to the owner. Our results suggested that patients with preoperative clinical signs of advanced liver disease can safely undergo an LLB.

Five dogs did not survive to discharge following LLB in the present study. All of these patients survived the immediate postoperative period but were euthanized a median of 3 days (range, 2 to 4 days) after the procedure because of deterioration in clinical status and guarded prognosis on the basis of final biopsy results. The severity of end-stage liver disease is well documented and beyond the scope of this report. These patients had no documented complications associated with the laparoscopic procedure and were euthanized because of underlying disease.

A twisting technique was used by surgeons at both study facilities to remove each of the LLB samples collected. This was done because twisting of small vessels may assist with hemostasis by allowing vessel spasm as well as disruption of the subendothelial collagen to initiate primary hemostasis. This technique has been previously reported yet to our knowledge, no controlled studies have been performed to determine whether it decreases blood loss during this procedure.

For 7 of the patients of this report, a single-port laparoscopic procedure was used for LLB. This technique is a new emerging platform in human surgery that reduces the number of laparoscopic ports to 1 single incision; this has, in theory, advantages of less pain, faster recovery, and better cosmesis, compared with conventional laparoscopic surgery. Potential drawbacks to this technique include loss of triangulation, instrument interference, and increased technical difficulty. Future studies are needed to determine whether this surgical technique has similar benefits in veterinary patients to those described in the human literature.

Ascites is considered to be a relative contraindication to laparoscopy in veterinary medicine because it may inhibit adequate visibility. In humans, ascites is considered a contraindication for diagnostic laparoscopy because insufflation can additionally cause froth to form in the fluid, further prohibiting appropriate visual access. Buote et al described ascites as having a protective effect on the risk of conversion in their study population. This was hypothesized to result from ascites being caused by diffuse liver disease, in which conversion for direct intervention was not appropriate. In our population of patients, 14 of 106 (13.2%) had ascites. The fluid was removed by suction to allow visual examination, and there were no concerns regarding postbiopsy hemorrhage, site monitoring, or appropriate sample collection for these patients. Our results supported that ascites may not be a contraindication for veterinary diagnostic laparoscopy. Given the electrolyte shifts, hypoalbuminemia, and decreased oncotic pressure that may occur following removal of ascites fluid, some surgeons propose this fluid should not be removed and the presence of ascites is another indication for laparoscopy in patients with advanced liver disease. None of these potential complications occurred within this patient population. Future studies are needed to direct the intraoperative management of patients with ascites and advanced liver disease during laparoscopic procedures.

Two dogs of this study had intraoperative complications, both of which were splenic lacerations that occurred during trocar placement when the multiport technique was used. Both lacerations resulted in uncon-
controlled hemorrhage and conversion to open laparotomy. We did not identify any significant risk factors for these complications; however, this result was not unexpected given the low rate of complications reported. The CIs surrounding the measures of association indicated that clinically significant associations could still exist but were not identified because of type II error.

Splenic injuries have been reported in dogs during initial abdominal access for laparoscopic procedures and during establishment of the pneumoperitoneum by both the Veress needle and Hasson techniques.11,27,29,30 These complications highlight the need for caution during initial abdominal access and trocar placement. These risks have been cited in previous papers describing the single-port technique, and in 1 report,11 the authors described providing digital counter traction on the multitrocar port during cannula insertion and only inserting the 3 cannulas partially through the multitrocar port before abdominal insufflation as a means of preventing iatrogenic injury. Once the abdomen was fully insufflated, the cannulae could be further advanced into the multitrocar port without risk of splenic trauma.11

All patients in this study had a sample of diagnostic quality collected. This is in concordance with previous reports of LLB samples.17 Previous evaluation of LLB samples collected with a 5-mm biopsy cup forceps showed that a tissue sample of approximately 1 cm³ provides a diagnostic quality sample with approximately 8 to 13 portal triads available for examination17,23 and is compliant with recommendations in the human literature that 6 to 8 portal triads be available for adequate histopathologic evaluation.10

The results of the present study revealed a lower intraoperative complication and conversion rate for LLB than has been previously published in the veterinary literature. It is possible that the results of this study differ from those of other reports because of variations in the criteria used to define a complication. One study17 reporting the results of LLB included patients that developed anemia requiring a packed RBC transfusion as having complications. Although postoperative hemorrhage and anemia caused by blood loss is an understandable concern, it may be difficult to discern whether these patients required a transfusion secondary to their underlying disease rather than blood loss incurred by surgery. Additionally, another report regarding diagnostic laparoscopic procedures included findings for both dogs and cats as well as patients that underwent other laparoscopic-assisted procedures in the evaluation.18 In those reports, the need for concurrent laparoscopic-assisted procedures may have affected the means by which liver biopsy specimens were collected as well as predisposing the patients to complications associated with the other surgical techniques. Alternatively, other more severe, underlying etiologies may have dictated the need for additional diagnostic procedures, and those conditions could have placed the patients at higher risk of complications. One report18 highlighting diagnostic laparoscopy included patients that had emergent and elective conversions in calculation of the conversion rate. In that report, patients for which the conversion was deemed elective did not have problems associated with the diagnostic laparoscopic procedure; rather, findings on the initial visual exploration prompted the decision to convert to laparotomy.18 This would also confound determination of the complication rate related to LLB.

Limitations of the present study included its retrospective nature and the lack of standardization regarding preoperative management, anesthetic protocol, surgical techniques, and surgeon. Although complications in this population of patients were rare, the criteria used to determine which patients received FFP transfusions or other supportive care were not uniform. These treatments were administered at the discretion of the overseeing clinician, but a more controlled prospective study could help distinguish which patients would truly benefit from more intensive preoperative management. The anesthesia protocols were determined at the discretion of the anesthesiologist responsible for the patient. Patients with liver disease may prove to be challenging anesthesia subjects because they can have abnormalities of glucose metabolism, drug metabolism, coagulation, and neurologic function and presence of ascites, all of which are complicating factors during the perioperative period.31 Within our patient population, drug selection was not standardized, and it should be mentioned that several commonly administered anesthetic drugs have been linked to increased splenic size32 and this could have contributed to iatrogenic splenic laceration resulting in the need for conversion to laparotomy in 2 dogs. The LLB procedures in the present study were performed by either an attending board-certified surgeon proficient in laparoscopy or by a surgical resident directly supervised by a board-certified surgeon. This led to inclusion of surgeons with various degrees of laparoscopic experience. The surgical technique, including the number and location of ports, was at the discretion of the primary surgeon.

The results of this multi-institutional study suggested that the LLB is a safe and effective method for obtaining a histopathologic diagnosis of hepatic disease in dogs. Future controlled studies are indicated to determine whether clinical benefits exist for the laparoscopic technique over traditional open and percutaneous needle aspiration techniques. In the dogs of this study, LLB was associated with a low perioperative morbidity rate, and the biopsy specimens obtained were of diagnostic quality. Given the previously reported advantages of laparoscopic surgery, further studies are warranted to determine whether this method can be considered the gold standard for collecting a liver biopsy specimen in veterinary medicine.

Acknowledgments
Presented in abstract form at the American College of Veterinary Surgeons Surgery Summit, San Diego, October 2014.
No external funding was used in this study.
The authors declare that there were no conflicts of interest.

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Footnotes


b. Hopkins II 5 mm 30° telescope, Karl Storz Veterinary Endoscopy Inc, Goleta, Calif.

c. Endoflator, Karl Storz Veterinary Endoscopy Inc, Goleta, Calif.

d. Ternamian Endotip, Karl Storz Veterinary Endoscopy Inc, Goleta, Calif.

e. SILS Port, Covidien Ltd, Norwalk, Conn.

f. 5-mm blunt probe, Karl Storz Veterinary Endoscopy Inc, Goleta, Calif.

g. 5-mm biopsy cup forceps, Karl Storz Veterinary Endoscopy Inc, Goleta, Calif.

h. Stata Statistical Software. Release 12. Stata Corp, College Station, Tex.

References


