Techniques for Laparoscopic and Laparoscopic-Assisted Biopsy of Abdominal Organs

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Abstract: Multiorgan pathology is a common finding during the diagnostic work-up of complex medical diseases in small animals. Collection of cytologic or biopsy samples from several abdominal organs can give the clinician crucial information in guiding therapy. Although many modalities are available for sample collection, laparoscopic and laparoscopic-assisted techniques offer a minimally invasive approach for collection of high-quality biopsy samples from multiple organs during one anesthetic episode. This article discusses the laparoscopic approaches and techniques for multiorgan biopsy in cats and dogs.

D iagnostic evaluation of many different medical conditions can be assisted by obtaining biopsy samples from multiple abdominal organs. This sample collection has traditionally been performed several ways.

“Open” celiotomy has the advantage of allowing thorough inspection of, and easy access to, all abdominal organs. However, it is the most invasive technique, sometimes necessitating an incision from the xiphoid process to the pubis for access to the cranial and caudal abdominal structures.

Ultrasound-guided fine-needle aspiration or needle-core biopsy techniques can be used for obtaining samples from the liver, pancreas, kidneys, and mesenteric lymph nodes.1-3 Ultrasound-guided techniques are minimally invasive, but they require a skilled ultrasonographer, do not allow access to all areas of the peritoneal cavity, and have been shown to produce inferior samples in many cases when compared with open surgical or laparoscopic biopsy techniques.1-3

Flexible gastroscopy and small intestinal endoscopy can be used for harvesting gastric and small intestinal biopsy samples.1-6 These techniques have advantages and disadvantages versus surgical biopsy techniques.4 Full-thickness intestinal biopsy samples cannot be harvested endoscopically, and access to the lower small intestine is not possible with currently available endoscopic technology. Some studies have shown the limitations of endoscopically collected biopsy samples for diagnosing certain conditions (e.g., lymphoma).5,6 Flexible endoscopy does, however, have the advantage of being an outpatient procedure, allowing direct visualization of mucosal lesions, and avoiding the reported 12% dehiscence rate of full-thickness surgical biopsies.7

Laparoscopic procedures (performed entirely within the peritoneal cavity) and laparoscopic-assisted procedures (which use laparoscopic manipulation to exteriorize organs for extraperitoneal surgery) can allow a thorough evaluation of most abdominal organs. It is not known whether laparoscopic exploration of the abdominal cavity can be as thorough as open exploration. However, almost all abdominal structures are visible laparoscopically, and the success of laparoscopic exploration of the peritoneal cavity
is limited only by the patience of the surgeon. For example, laparoscopic examination of the full length of the bowel is possible but time consuming. Another important variable to consider is the reliability of preoperative abdominal imaging. In most cases, when preoperative imaging has identified the location of focal lesions or when diffuse disease only is suspected, the need for laparoscopic visualization of all organs is debatable.

Compared with open celiotomy, a laparoscopic approach has been shown to result in less postoperative pain and a faster return to normal activity and may result in fewer and less severe wound-healing complications. This article presents some of the technical aspects of harvesting biopsy samples using laparoscopic or laparoscopic-assisted techniques. These techniques allow clinicians to offer their clients a high likelihood that, similar to open surgery, they will obtain high-quality diagnostic samples from all the necessary organs during one procedure, when such an approach is clinically indicated.

In choosing which diagnostic techniques to use, clinicians must balance the desire to obtain high-quality biopsy samples from all the organs in which pathology is suspected in the least invasive way possible against owners’ financial constraints and tolerance for the risk of potential complications.

**Patient Preparation and Positioning**

For all of the techniques described below, the patient is placed in dorsal recumbency and the abdomen is liberally clipped from 2 inches cranial to the xiphoid process to the pubis. Laterally, the patient is clipped to approximately the midabdomen level as for a traditional open celiotomy. It is important that wide clipping and aseptic preparation be performed in the unlikely event that conversion to an open procedure becomes necessary. Lateral recumbency can be used for access to certain individual organs, but when examination or biopsy of multiple organs is desired, I prefer dorsal recumbency and the use of a subumbilical telescope port.

**Abdominal Access and Port Positioning**

A subumbilical telescope port can be placed using either the Hasson or the Veress needle technique. For the following procedures, instrument port position depends on which techniques are to be performed. In most cases, multiple organs can be accessed through a small number of common instrument ports or one small “assist” incision (an incision 2 to 4 cm in length created by enlargement of a previously placed instrument port for exteriorization of abdominal organs). Before beginning the procedure, the surgeon should decide the minimum combination of instrument ports that will provide access to all organs to be biopsied. Usually, two or three instrument ports are adequate.

**Liver Biopsy**

Due to its fixed location and friable nature, the liver is biopsied using totally laparoscopic techniques. When multiple organ biopsy samples are needed, the liver sample should be taken first so that if laparoscopic-assisted procedures are subsequently performed through larger port incisions, it will not be necessary to reestablish the pneumoperitoneum for liver biopsy at the end of the procedure. However, reinsufflation may be recommended if the surgeon wishes to confirm adequate hemostasis before completing the surgery. It is wise to consider performing a full coagulation profile before laparoscopic liver biopsy. I place a pretied loop ligature (described below) in animals with coagulopathy or when harvesting large samples, although the need or benefit of this practice has not been evaluated scientifically.

In most cases, when a liver biopsy is performed in isolation for diffuse hepatopathy, a single instrument port suffices. The port is placed under direct visualization in a paramedian
position in either the right or left cranial quadrant of the abdomen. Care should be taken not to place the cannula cranial to the last rib, which risks entering the thoracic cavity and could precipitate pneumothorax. A 6-mm trocar–cannula assembly can be placed to accommodate 5-mm cup biopsy forceps. A second port can be placed on the contralateral side if the surgeon plans to use a hemostatic device (vessel-sealing device or ligature) to harvest the sample. If a focal liver lesion has been diagnosed from preoperative imaging, the instrument port should be placed on the side of the focal lesion. If other laparoscopic procedures are to be performed in addition to the liver biopsy, the instrument ports used for those procedures can usually be used to access the liver, thus minimizing the number of necessary ports.

The simplest way to perform a liver biopsy is by using 5-mm laparoscopic cup biopsy forceps to harvest pieces of liver from the edge of a lobe. The tissue is grasped and gently twisted until it separates from the rest of the lobe. Care should be taken during this process to avoid tearing liver parenchyma by rough handling, which can lead to excessive hemorrhage. Performed correctly, this technique has been shown to cause minimal bleeding in healthy dogs and to yield good-quality tissue samples.\textsuperscript{11,12} Coagulation of the periphery of the biopsy site with a vessel-sealing device has been shown in some studies to reduce hemorrhage associated with the procedure.\textsuperscript{11,12}

Several samples can be taken from multiple lobes. By passing the telescope caudally or cranially around the falciform fat, access to both right and left sides of the liver is possible. If the surgeon judges that excessive hemorrhage is occurring after liver biopsy, a piece of gelatin sponge or oxidized regenerated cellulose can be passed through a port and manipulated into position at the biopsy site to promote clot formation and hemostasis. In all cases, the biopsy sites should be visualized until the surgeon is convinced that all hemorrhage has ceased before removing the telescope.

If hemorrhage is of concern (e.g., in animals with advanced hepatic failure, focal or highly vascular lesions, or known coagulopathies), it may be preferable to apply a pretied loop ligature or extracorporeally assembled loop ligature to ligate the tip of the lobe before taking biopsy samples. This ligation decreases the chance of severe hemorrhage; however, a second port must be placed for application of the ligature. A modified Roeder laparoscopic slipknot is used. The loop is passed through the instrument cannula either with the plastic application device (for commercial pretied loop ligatures [e.g., Endoloop, Ethicon...)

QuickNotes

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Endosurgery, Cincinnati, OH]) or with a knot pusher (for self-assembled loop ligatures). It must then be manipulated into position around the tip of a liver lobe. A blunt probe can aid in elevating the liver lobe during loop positioning. When the loop is in position, it is tied by advancing the plastic application device or knot pusher (for self-assembled loops) against the modified Roeder knot until it securely ligates the blood vessels and bile ducts within the parenchyma. The liver tissue distal to the ligature can then be cut with endoscissors and withdrawn through a cannula, or multiple bites can be taken with laparoscopic cup biopsy forceps.

If a large focal liver mass is to be biopsied, extreme care should be taken because these lesions are often very vascular. Consideration should be given to taking a needle-core biopsy sample under laparoscopic guidance before collecting larger samples to gauge the level of hemorrhage that will result. Otherwise, a loop ligature should be used to harvest the sample to reduce the risk of profuse hemorrhage. It may be advisable to use a specimen retrieval bag to remove larger samples. Extension of the port site may be needed to recover these samples.

**Kidney Biopsy**

If a single kidney is to be biopsied, a needle-core biopsy technique is usually selected. Theoretically, no instrument port is required for this technique because the biopsy needle can be passed percutaneously into the peritoneal cavity in a location directly ventral and somewhat caudal to the kidney. However, it is helpful to have one instrument port available for passage of a blunt probe that can help manipulate the kidney into position for the biopsy and place pressure on the biopsy site after needle withdrawal to minimize hemorrhage from the site. This instrument port can be placed on the ventral midline 5 to 10 cm cranial or caudal to the telescope port. If an instrument port is available, a piece of oxidized regenerated cellulose can be placed over the biopsy site if hemorrhage is profuse. A significant benefit of laparoscopy is the ability to visualize the amount of hemorrhage from the kidney and ensure that hemostasis has been achieved before closure.

I prefer to use an automatic spring-activated needle-core biopsy needle to decrease the possibility of inadvertent premature needle withdrawal from the parenchyma that can occur from excessive movement with manually activated Tru-Cut needles. Under direct visualization, the biopsy needle is guided into the parenchyma and directed to pass across the renal cortex to maximize the number of glomeruli recovered. The sample is taken by activating the biopsy needle, which is subsequently withdrawn from the peritoneal cavity to recover the sample. Usually, one to two samples are taken from one or both kidneys, depending on the nature of the pathology suspected. If the needle is placed too deeply into the medulla, fewer glomeruli may be recovered and there is a greater risk of hemorrhage from arcuate vessels. The laparoscopic technique using a 14-gauge needle has been shown to give superior-quality biopsy samples compared with ultrasonographic guidance of the same-size needle.

**Gastrointestinal Biopsy**

Biopsies of the small intestine are usually performed using a laparoscopic-assisted technique. In humans, in which the small intestinal lumen is significantly larger, endoscopic stapling devices can be used to resect small antimesenteric sections of small intestine. This would likely result in excessive compromise of the luminal diameter in small animals and so is not practical in these patients. Exteriorization of bowel segments through a small assist incision, followed by standard small intestinal biopsy sample collection from the antimesenteric border, is usually the best technique in dogs and cats.

A technique for laparoscopic-assisted small intestinal biopsy that involves placement of a paramedian port lateral to the right rectus abdominis muscle has been reported. A 10-mm Babcock forceps is used to grasp a section of duodenum, jejunum, or ileum and bring it to the port-site incision. The

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The trocar–cannula assembly is removed while the Babcock forceps is still grasping the small intestinal loop. To exteriorize the loop of intestine, the port incision can be enlarged to 2 to 4 cm, as needed. A sample can then be harvested in standard fashion. Using this technique, an enterostomy feeding tube can also be placed at the time of biopsy, if clinically indicated. If a feeding tube is to be placed, the section of the small intestine that is grasped must be chosen carefully because duodenostomy and jejunostomy feeding tubes are usually placed in the midduodenal or proximal jejunal areas to optimize nutritional absorption during feeding.

I often use a modification of this technique to allow easier access to the small intestine and other organs. Once any laparoscopic procedures (e.g., liver biopsy) are completed, the telescope is removed from its subumbilical location and the port incision enlarged to 3 to 4 cm to allow placement of a 2- to 4-cm laparoscopic wound retractor (Alexis Wound Retractor, Applied Medical Corp, Rancho Santa Margarita, CA). Once the retractor is in place, the circumferential force exercised at the wound margin holds open a small circular orifice into the peritoneal cavity (FIGURE 2). This relatively inexpensive device has several advantages. It prevents compression of the mesenteric root and subsequent vascular compromise compared with exteriorization of the intestine through an unretracted incision, thereby allowing large sections of intestine to be exteriorized for examination at any one time (FIGURE 3). It also allows other structures such as the pancreas and mesenteric lymph nodes to be elevated enough to easily collect biopsy samples (FIGURE 4). If the assist incision is directed cranially from the original subumbilical port location, it is usually possible to obtain a sample from the stomach, although this may be challenging in large or deep-chested dogs. The wound retraction device also prevents contamination of the wound margin and has been shown in some human studies to decrease wound infection rates.15 Alternatives to the wound retractor device include the placement of Gelpi retractors or a small Balfour retractor in the wound to open the incision and decrease compression of the mesenteric root.

There are limitations to the use of small assist incisions for abdominal organ biopsy. There are limitations to the use of small assist incisions for abdominal organ biopsy.

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Large segments of small intestine can be removed through the laparoscopic-assisted incision. Using a wound retraction device minimizes pressure on the mesenteric root, preventing vascular engorgement of exteriorized bowel and facilitating its return to the peritoneal cavity after completion of the biopsy.

The duodenum has been partially exteriorized through the assist incision. A biopsy sample can easily be harvested from the duodenum in addition to a pancreatic sample, if clinically indicated.

Surgical Video

To see videos demonstrating the placement of a wound retractor and use of this device in exteriorizing a large section of intestine, visit CompendiumVet.com.
exteriorized, although full-thickness colonic biopsy is strongly discouraged because of the high morbidity associated with dehiscence in this area and the excellent diagnostic quality of colonoscopic biopsy samples.4

With either the modified or unmodified technique, once the intestine is exteriorized, samples can be taken using a technique similar to that used during open celiotomy. Using a stay suture of 4-0 suture material, a small, full-thickness bite is placed on the antimesenteric side of the intestine. A number 11 blade is used to incise the intestine around the stay suture, ensuring that an adequate sample of mucosa as well as submucosa and muscularis is harvested (FIGURE 5). A skin biopsy punch can also be used for small intestinal biopsy sample collection.16 The incision(s) can be closed using 3-0 or 4-0 monofilament absorbable suture material (e.g., polydioxanone) in a simple, interrupted or simple, continuous suture pattern. If significant narrowing of the luminal diameter is anticipated after suturing, the incisions can be closed in transverse fashion to preserve the luminal diameter as much as possible. After closure of the biopsy site is complete, local lavage can be performed away from the abdominal incision site, thus preventing any contamination of the peritoneal cavity with lavage solution (FIGURE 6). After completion of all procedures, all abdominal wall incision sites can be closed routinely.

Pancreatic Biopsy
A laparoscopic or laparoscopic-assisted technique can be used for pancreatic biopsy. A single instrument port can be used for the laparoscopic technique if a punch technique is used, although a second port is necessary if use of a vessel-sealing device or ligature is desired. A second instrument port may also be necessary if significant manipulation of the surrounding organs is needed to obtain an unobstructed view of the pancreas. A pancreatic biopsy is usually performed in addition to biopsy of other organs; therefore, access is usually from instrument ports positioned for these other biopsy procedures.

The tip of the right (duodenal) limb of the pancreas is usually the simplest to sample.

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Once exteriorized, the small intestine can biopsied in standard fashion. The use of a small-gauge stay suture placed at the antimesenteric border, followed by an incision with a number 11 blade, helps in the atraumatic harvesting of small intestinal biopsy samples.

The laparoscopic-assisted technique allows local lavage to be performed in a location away from the opening into the peritoneal cavity, thus minimizing peritoneal contamination.
Creas from the periphery of the lobe (FIGURE 7). Care should be taken to avoid performing a biopsy on the body of the pancreas (to avoid damaging pancreatic ducts) or the area where the caudal pancreaticoduodenal vessels enter the tip of the right pancreatic limb. This technique has been shown to be safe in healthy dogs, with no significant clinical abnormalities detected postoperatively, although histologically some inflammation is seen around biopsy sites.

To reduce hemorrhage, several other techniques can be used. A pretied loop ligature can be placed around a piece of pancreas to be biopsied, or hemostatic clips can be placed in a V-shape around the tissue segment to be excised. A vessel-sealing device can also be used to harvest the sample. A recent study compared use of the Harmonic Scalpel device (Ethicon Endosurgery Inc, Cincinnati, OH) with the placement of hemostatic clips to harvest pancreatic biopsy samples laparoscopically. The Harmonic Scalpel led to a reduction in hemorrhage but resulted in significantly greater inflammation.

**Conclusion**

Laparoscopic and laparoscopic-assisted techniques can be used in combination to gather samples from multiple abdominal organs when diagnostic work-up of complex multiorgan pathology is performed. Even though conversion to an open approach should always be discussed with the owners, in most cases laparoscopic techniques can offer a one-procedure approach for collection of high-quality biopsy samples from multiple organs that is less invasive than open celiotomy.

**References**

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