Canine Laparoscopic and Laparoscopic-Assisted Ovariohysterectomy and Ovariectomy

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ABSTRACT: As the benefits of minimally invasive surgery are more widely recognized by veterinarians and their clients, laparoscopic sterilization of female dogs is growing in popularity. Laparoscopic ovariohysterectomy and ovariectomy procedures in dogs are associated with less postoperative pain and a faster return to normal activity versus open sterilization procedures. The advent of newer laparoscopic electrocoagulation devices has further increased the technical feasibility and popularity of these procedures.

The first canine laparoscopic sterilization procedure was reported by Wildt and Lawler in 1985. Since then, laparoscopic ovariohysterectomy (OVH) and ovariectomy (OVE) techniques have been extensively researched and developed. While the standard of care for sterilization of female dogs in the United States has been OVH, OVE procedures have been routinely performed in some European countries for years. No significant differences have been noted between OVH and OVE in postoperative complications, such as the incidence of urethral sphincter mechanism incompetence, endometritis, pyometra, or postoperative weight gain. Furthermore, the incidence of uterine neoplasia in dogs is low, with most uterine tumors being benign. Due to the potential benefits associated with OVE, including decreased surgical time and patient morbidity (e.g., smaller incision size, decreased intraoperative trauma), the popularity of this procedure will likely grow.

ADVANTAGES
The advantages of laparoscopy over open surgical procedures are well established in humans and include decreased pain, shorter recovery times, shorter hospital stays, and fewer postoperative complications (e.g., wound infection, dehiscence, hernia formation). Similarly, the advantages of laparoscopic sterilization procedures in dogs include less postoperative pain, lower postoperative morbidity, superior visualization, and faster return to normal activity.

DISADVANTAGES
The potential disadvantages of laparoscopic OVH in dogs include the need for specialized training, the cost of equipment, and the need for a surgical assistant for most described techniques. The equipment necessary for laparoscopic sterilization procedures is more expensive than that required.
for open procedures. However, the versatility of the equipment for other laparoscopic and endoscopic techniques makes it a beneficial investment for veterinarians seeking to offer a variety of minimally invasive techniques to their clients. Depending on the experience of the laparoscopic surgeon and the available instrumentation, surgical time can be greater than for “open” OVH or OVE. However, surgical time decreases rapidly with experience.5

CONTRAINDICATIONS
There are few contraindications to laparoscopic sterilization. Absolute contraindications include the presence of a diaphragmatic hernia and septic peritonitis, whereas relative contraindications include small patient size (<2 kg) and obese body condition.14 Laparoscopic OVH of animals with pyometra has been performed successfully; however, a ruptured pyometra resulting in a septic abdomen is an indication to convert to an open technique.15 The presence of a diaphragmatic hernia may result in a pneumothorax when the abdomen is insufflated; therefore, laparoscopic sterilization before hernia repair is not recommended.

INSTRUMENTATION
Essential instrumentation for laparoscopic OVH or OVE includes a laparoscope, video imaging system, mechanical gas insufflator, and light source; trocar–cannula assemblies; and laparoscopic instrumentation (e.g., palpation probe, forceps).14 An adjustable surgical table capable of tilting laterally greatly facilitates visualization of the ovaries but is not essential. Motorized float tables are ideal but expensive. A less expensive tabletop-mounted tilting device is also available for this purpose (TT Endoscopic Positioner, Karl Storz Veterinary Endoscopy). A laparoscopic suction/irrigation device may also be helpful if intraoperative hemorrhage is encountered. Without such a device, hemorrhage can obscure the field of view and require conversion to an open procedure. Other recommended instruments are listed in Box 1. The delicate nature of, and the expense associated with, the instrumentation required for laparoscopy warrant proper training of all personnel involved in the surgical application, cleaning, disinfection, and sterilization of these items.

METHODS OF OVARIAN PEDICLE HEMOSTASIS
Many different hemostatic devices have been shown to be safe for use in laparoscopic OVH or OVE, including extracorporeal sutures, laparoscopic clips, bipolar and monopolar electrocautery units, lasers, and bipolar or ultrasonic vessel-sealing devices.3,5,6,13 A prospective, randomized clinical trial comparing the use of extracorporeal sutures (modified Roeder knots), laparoscopic clips, and a bipolar vessel-sealing device for ovarian pedicle ligation found that the bipolar vessel-sealing device was associated with significantly shorter surgical times and a lower incidence of hemorrhage from the ovarian pedicle.5 It is strongly recommended, therefore, that practices planning to offer laparoscopic OVH or OVE on a regular basis invest in a vessel-sealing device, as significant decreases in surgical time will be seen. Several devices are available, such as the LigaSure (Valleylab Inc., Boulder, CO), the Enseal (SurgRX Inc., Redwood City, CA), and the Harmonic Scalpel (Ethicon Endosurgery Inc., Cincinnati, OH), among others. The first two devices are indicated to seal arteries and veins up to 7 mm in diameter, whereas the ACE version of the Harmonic Scalpel is indicated to seal vessels up to 5 mm in diameter. If used correctly, these devices will seal the ovarian pedicle safely and without significant hemorrhage, even in large and giant-breed dogs. Regardless of the method of ovarian pedicle ligation implemented, care must be taken to avoid inadvertent injury to other abdominal organs and the body wall, and the pedicles should be closely monitored for hemorrhage.

ANESTHETIC CONSIDERATIONS
The most important anesthetic considerations for laparoscopic sterilization are related to abdominal insufflation. Respiratory and cardiovascular depression can occur secondary to excessive pressure.
exerted on the diaphragm and vascular structures of the peritoneal cavity. Intraabdominal pressure is monitored by the mechanical gas insufflator and should be maintained at around 10 to 12 mm Hg—definitely below 15 mm Hg—to prevent potential cardiovascular and respiratory depression. Carbon dioxide (CO₂) is the gas of choice to achieve a pneumoperitoneum. Insufflation with air may result in fatal air embolism, and the use of nitrous oxide (N₂O) is discouraged due to the potential for combustion when electrocautery devices are used. Hypercapnia can occur during insufflation for two main reasons: increased pressure on the diaphragm causing a reduction in tidal volume, thus compromising ventilation, and rapid absorption of CO₂ through the peritoneal lining. It is therefore recommended that CO₂ be monitored via either capnography or blood gas analysis and that ventilation be adjusted accordingly. If CO₂ levels are consistently high during the surgical procedure (PaCO₂ > 50 to 55 mm Hg; end-tidal CO₂ > 45 mm Hg), intermittent positive-pressure ventilation or mechanical ventilation should be considered.

Positioning of Surgeon and Tower
Ideally, the surgeon and assistant (laparoscope operator) should be positioned in a straight line with the ovary and the laparoscopy tower. In this position, the surgeon stands on one side of the dog, opposite one ovary, with the tower (video-imaging system, insufflator, light source) positioned on the opposite side of the table. However, the tower will need to be moved to the opposite side of the table to manipulate the opposite ovary. Alternatively, the tower can be placed at the caudal end of the patient, thus allowing visualization from both sides of the table without having to move the tower intraoperatively.

Patient Preparation and Positioning
The patient is placed in dorsal recumbency, and the ventral abdomen is clipped from the xiphoid to the pubis and aseptically prepared. When the transabdominal suture technique is used, a particularly wide area needs to be clipped to maintain sterility in the area where the suture is passed. If an adjustable table is used, the patient can be placed in a Trendelenburg position (head 15° to 30° below the pelvis) to permit the abdominal organs to migrate cranial, although this is not mandatory. After port placement, it is important that the patient be tilted (15° to 25°) to the left and right to facilitate visualization of the respective ovaries. Expression of the urinary bladder before surgery aids in visualization.

Establishment of a Pneumoperitoneum
Abdominal access and establishment of a pneumoperitoneum can be accomplished by using either a Veress needle or the Hasson technique. Regardless of the technique, when the first trocar–cannula assembly is placed, the instrument should be directed caudally and to the right to facilitate visualization of the respective ovaries. Expression of the urinary bladder before surgery aids in visualization.

A Veress needle consists of an outer, sharp-tipped needle with an inner, blunt, spring-loaded obturator. When the needle is advanced against the abdominal wall, the obturator retracts into the needle, thus allowing the sharp tip to penetrate the abdominal musculature. As soon as entry into the peritoneal cavity has been attained and resistance is lost, the obturator springs forward, thereby preventing injury to the abdominal organs by the needle. To place the Veress needle, a small, 2-mm skin incision is made just cranial to the umbilicus, and the needle is introduced by holding the outer hub of the needle so that the internal blunt obturator is free to move. Before the abdomen is insufflated, a “hanging drop test” is conducted to confirm the position of the needle.

Clinical Pearls
• The advantages of laparoscopic sterilization include improved visualization, decreased postoperative pain and morbidity, and a faster return to normal activity.
• Intraabdominal pressures should be maintained at no greater than approximately 10 to 12 mm Hg to prevent cardiovascular and respiratory compromise during anesthesia.
• Vessel-sealing devices decrease surgical time and provide excellent hemostasis.
• To avoid herniation of abdominal structures, care should be taken to close the body wall defect when a 5-mm or larger port is used.

SURGICAL TECHNIQUES
Multiple surgical techniques have been described for laparoscopic sterilization, including totally laparoscopic versus laparoscopic-assisted techniques, OVH versus OVE, and techniques differing in the number of ports established (three, two, or one). The three-median-port laparoscopic-assisted OVH technique and the two-port OVE technique are described below. Both provide good visualization of both ovaries, and the placement of the ports through the linea alba may result in less postoperative pain than techniques using paramedian ports placed through abdominal musculature. Techniques employing transabdominal suspension sutures may obviate the need for a surgical assistant.
Veress needle within the peritoneal cavity. For this test, a drop of saline is placed on the hub of the needle. If the needle is within the peritoneal cavity, the negative pressure of the cavity will pull the saline into the needle. If the needle is in the subcutaneous space or has penetrated an organ, no pressure difference will exist and the saline will remain on the hub. Once entry into the abdominal cavity has been confirmed, the hub of the needle is attached to the gas insufflator to produce a pneumoperitoneum. After the abdomen is insufflated to around 10 to 12 mm Hg, a trocar–cannula assembly can be introduced to establish the first port. A sharp trocar can be used to penetrate the peritoneal cavity because the pneumoperitoneum will help prevent injury to the abdominal organs; however, the surgeon’s index finger should be placed near the tip of the trocar–cannula unit to prevent inadvertent deep penetration into the abdominal cavity.

The Hasson technique avoids the blind introduction of a sharp needle and cannula into the peritoneal cavity. It is performed by making a 1-cm skin incision just caudal to the umbilicus, followed by blunt dissection down to the linea alba. A 3- to 4-mm incision is made through the linea alba, and a trocar–cannula assembly is introduced into the peritoneal cavity. The trocar should have a blunt tip to prevent injury to the abdominal organs. Penetration into the peritoneal cavity can be confirmed by observation of falciform fat through the incision before insertion of the trocar.

Once a pneumoperitoneum is established, the abdominal cavity should become tympanic. Improper placement of the Veress needle or cannula can result in inadvertent insufflation of the subcutaneous space, resulting in subcutaneous emphysema. Further evidence of improper placement is demonstrated on the insufflator: a high (>6 mm Hg) initial pressure within the peritoneal cavity combined with a low flow of CO₂ suggests that the end of the trocar is not positioned within the peritoneal cavity. If either of these situations occurs, the position of the needle or trocar should be checked before proceeding further.

**Laparoscopic-Assisted Ovariohysterectomy**

Following the introduction of the laparoscope, two 6-mm instrument cannulas are established 3 to 5 cm cranial to the umbilicus and 3 to 5 cm cranial to the pubis on the ventral midline (Figure 1). Each cannula is introduced by making a 1-cm skin incision at the proposed port site and inserting the trocar–cannula assembly. If a laparoscopic-assisted gastropexy is to be performed in conjunction with a laparoscopic OVH, the cranial port is established as a right paramedian port 3 to 5 cm caudal to the last rib and at the level of the lateral margin of the rectus abdominis muscle. When placing the cranial trocar, visualization of the site with the telescope can help in avoiding the falciform fat or other intraabdominal structures.

When instruments are being passed into the abdominal cavity, the camera should be directed at the instrument cannula, and the passage of the instrument to the area of interest should be visualized. A blunt probe is introduced through the caudal trocar and used to move the spleen and colon away from the body wall to visualize the left ovary. Once a clear view of the proper ligament is obtained, the blunt probe is replaced with laparoscopic Kelly forceps, which are used to grasp the proper ligament and elevate the ovary from the abdominal viscera and away from the body wall. A bipolar vessel-sealing device or laparoscopic clip applier is inserted through the cranial trocar and
used to sequentially break down the suspensory ligament, ovarian pedicle, and broad ligament. The proper ligament is released, and the forceps are removed. The surgeon and assistant then move to the opposite side of the animal, the animal is tilted in the opposite direction, and the laparoscopic tower is moved if necessary. The procedure is then repeated for the right ovary; to reveal the right ovary and proper ligament, the small intestine must be bluntly manipulated away from the body wall. The ovarian pedicles should be checked for hemorrhage directly after sectioning because they will be obscured from view at the end of the procedure.

After the right ovarian pedicle is sectioned, the laparoscopic Kelly forceps are used to draw the right ovary toward the caudal cannula. At this point, the pneumoperitoneum is evacuated to decrease tension as the uterus and ovaries are exteriorized (Figure 2). The caudal incision is then extended, and the laparoscopic Kelly hemostats and cannula are removed as a unit, allowing exteriorization of the right ovary and uterine horn. The left uterine horn is then exteriorized, followed by the left ovary. Care should be taken to minimize tension on the uterus and ovary, extending the incision as needed to facilitate exteriorization. Excessive tension can result in tearing of the uterus, hemorrhage, or damage to the ovary, which can lead to seeding of ovarian tissue into the peritoneal cavity or port site.

Once the ovaries and uterus are exteriorized, the ligation of the uterine arteries and transection of the uterine body are performed routinely. Following the removal of the ovaries and uterus, the caudal port is closed routinely, ensuring that the body wall is closed to prevent herniation of peritoneal structures through the port incisions. The camera is then reintroduced through the subumbilical port and a pneumoperitoneum briefly reestablished to ensure that the uterine stump is not bleeding. The pneumoperitoneum is released, the remaining trocars are removed, and the port incisions are closed routinely.

Laparoscopic Ovariohysterectomy
Laparoscopic OVH is performed as described above, except that the uterine body and arteries are ligated intracorporeally. The uterine arteries can be individually ligated using a bipolar vessel-sealing device or laparoscopic clips, and the uterine body can be ligated with a pre-tied loop suture or extracorporeal sutures. There is little advantage in performing the uterine body ligation intracorporeally as it is more time consuming, and removal of the uterus and ovaries requires extension of the caudal incision regardless of whether the uterine body is ligated extracorporeally or intracorporeally.

Laparoscopic Ovariectomy
Following introduction of the laparoscope, an instrument cannula is inserted midway between the subumbilical port and the pubis (Figure 3). The left ovary is located and the proper ligament grasped with laparoscopic Kelly hemostats. The ovary is elevated away from the abdominal viscera, and a transabdominal suspension suture is used to suspend the ovary from the abdominal wall (Figure 4). To place the suspension suture, a length of 2-0 to 3-0 suture material on a curved needle is introduced percutaneously in a loca-
The needle is introduced near the place where the ovary is being held against the body wall.

Once passed through the proper ligament, the needle is directed back through the body wall and grasped exteriorly to act as a stay suture.

Intraabdominal view of transabdominal retention suture placement. The laparoscopic Kelly hemostats are used to hold the ovary adjacent to the body wall as the suture is passed.

The ovary is held to the body wall by transabdominal retention suture following transection of the uterine horn.

Web Exclusives

A video showing the use of a bipolar vessel-sealing device to cut, seal, and coagulate the suspended distal uterine horn and ovarian pedicle during laparoscopic OVE can be viewed at CompendiumVet.com.

tion adjacent to where the ovary is being held up against the body wall. The suture is passed through the body wall, directed through the proper ligament under direct laparoscopic guidance, and then passed back out the body wall (Figure 4, bottom left and top right). Grasping the free ends of the suture next to the body wall with a hemostat serves to suspend the ovary away from the abdominal viscera. The laparoscopic Kelly hemostats are then released and removed from the instrument port, and a bipolar vessel-sealing device or clip applier is introduced. The proper ligament, mesovarium, and ovarian artery and vein are then transected in a caudal-to-cranial direction. The procedure is then repeated for the right ovary.

Once free, each ovary can be recovered through the caudal port incision, or both ovaries can be left attached to their respective suspension sutures until
the procedure is completed, facilitating their removal at the end of the procedure (Figure 4, bottom right). To remove the left ovary, the laparoscopic Kelly hemostats are inserted through the caudal port and used to grasp the ovary. The suspension suture is released, and the laparoscopic Kelly hemostats, attached ovary, and cannula are removed as a unit. The cannula is then reinserted and the right ovary is removed. Alternatively, a larger cannula that is large enough to allow withdrawal of the ovary through its lumen can be used in the caudal port. After the ovarian pedicles are inspected for hemorrhage, the port sites are closed routinely. The transabdominal suspension suture technique can also be used to reduce the laparoscopic-assisted OVH technique to a two-port technique.

**POSTOPERATIVE CARE**

Patients should be monitored for postoperative hemorrhage and managed with pain medications, although, in our opinion, postoperative pain medications can be used for a shorter period after laparoscopic surgery compared with traditional open sterilization techniques. Common analgesic protocols include an injectable opioid pain medication for the first 24 hours (e.g., buprenorphine 0.01 to 0.02 mg/kg q6–8h) and an NSAID for 3 to 4 days following the procedure. Incisions should be monitored daily for any increased swelling, pain, redness, and discharge.

**COMPLICATIONS**

Complications following open OVH surgery include incisional dehiscence, hemorrhage, stump pyometra, draining tracts, granuloma formation, partial colonic obstruction, ovarian remnant syndrome, ureteral injury, urinary incontinence, seroma formation, self-trauma, and anesthesia accidents. 21–27 Similar complications can be assumed to occur in laparoscopic OVH/OVE surgery, although the overall complication rate of laparoscopic surgery in small animals appears to be low. Reported complications in studies of laparoscopic OVH include subcutaneous accumulation of CO₂, omental herniation, seroma formation, minor splenic hemorrhage, and minor pedicle hemorrhage. 2–5 Major complications of laparoscopic surgery in small animals include anesthesia- and cardiovascular-related complications, inadvertent injury to other abdominal organs or the body wall, and hemorrhage. 3,4,16 A fatal gas embolism has been reported in a dog that had inadvertent insertion of a Veress needle into the spleen. 18 Additionally, inappropriate insufflation can result in pneumothorax in animals in which the diaphragm is inadvertently penetrated or in animals with a diaphragmatic hernia. 14 Inadvertent iatrogenic injury to other abdominal structures or hemorrhage that obscures visualization during laparoscopy are indications for conversion to an open procedure.

**REFERENCES**


