Lift laparoscopy in dogs and cats: 12 cases (2008–2009)

Boel A. Fransson, DVM, PhD, DACVS, and Claude A. Ragle, DVM, DACVS, DABVP

Objective—To describe clinical and physiologic changes during lift laparoscopy in dogs and cats and determine immediate surgical outcome.

Design—Retrospective case series.

Animals—Client-owned dogs (n = 7) and cats (5).

Procedures—A custom-made lift device was used to retract the abdominal wall for laparoscopic instrumentation. The lift device was used first in 3 dog cadavers to assess the risk of complications. Thereafter, the device was used for routine laparoscopic procedures in client-owned animals. Data collected from medical records included signalment, body weight, clinical signs, diagnosis, surgery type and duration, conversion from laparoscopic to open surgery, preoperative American Society of Anesthesiologists score, mean intraoperative respiratory rate, mean and peak end-tidal partial pressure of CO2, during the laparoscopic surgery, ventilation method, mean saturation of hemoglobin with O2, mean and systolic arterial pressures during the laparoscopic surgery, total anesthesia time, signs of pain immediately after recovery, duration of hospitalization, and postoperative complications.

Results—Lift laparoscopy was successfully performed in 10 of the 12 patients. No adverse effects were noted with the use of this technique. However, in 1 dog and 1 cat, conversion to laparotomy was necessary because of poor visualization.

Conclusions and Clinical Relevance—Results suggested that lift laparoscopy is feasible in dogs and cats and is an option that can be used in clinical practice, especially if creation of positive-pressure pneumoperitoneum is not desirable. (J Am Vet Med Assoc 2011;238:1574–1579)

---

With conventional laparoscopic surgery, positive-pressure pneumoperitoneum is induced and maintained through insufflation of CO2 to allow visualization of the abdominal contents and surgical instruments. Numerous reports in the human and veterinary medical literature have documented important physiologic changes induced by creation of pneumoperitoneum with CO2 insufflation. The increased intra-abdominal pressure associated with positive-pressure pneumoperitoneum induces changes in hemodynamic and respiratory variables in healthy patients. Increases in heart rate, systemic vascular resistance, and arterial and central venous pressures and decreases in cardiac output and pulmonary compliance have been reported in human and equine patients undergoing conventional laparoscopy with positive-pressure pneumoperitoneum. In comparison with laparotomy, laparoscopy with CO2 pneumoperitoneum for cholecystectomy results in an increase in right-sided and left-sided cardiac and pulmonary pressures and a significant decrease in cardiac contractility and function. Experimentally, healthy dogs develop hemodynamic changes and aci-

---

**Abbreviations**

ASA | American Society of Anesthesiologists  
IOR | Interquartile range  
MAP | Mean arterial blood pressure  
PetCO2 | End-tidal partial pressure of CO2  
SAP | Systolic arterial blood pressure
and stretching of the right phrenic nerve.\textsuperscript{14,15} Other reported advantages of lift laparoscopy, in comparison with conventional laparoscopy, include lower cost and the option of performing laparoscopy with regional versus general anesthesia.\textsuperscript{8,10} However, lift laparoscopy has been criticized for causing more abdominal pain and for providing poor exposure, compared with conventional laparoscopy and pneumoperitoneum.\textsuperscript{6,17}

To our knowledge, the outcome of lift laparoscopy in dogs and cats has not yet been documented. It is possible that differences between species would make the use of abdominal lifts less valuable in dogs and cats than in people. However, considering the well-documented hemodynamic changes associated with pneumoperitoneum, use of abdominal wall lift laparoscopy may provide a safer alternative to conventional CO\textsubscript{2} pneumoperitoneum in veterinary patients with underlying cardiopulmonary disease. The purpose of the study reported here was to describe clinical and physiologic changes during lift laparoscopy in dogs and cats and determine immediate surgical outcome.

**Materials and Methods**

**Design of abdominal lift device and cadaver study**—A lift device for abdominal wall retraction was custom made out of medical-grade stainless steel. The design was based on published reports\textsuperscript{16–20} and consisted of a 300° spiral retractor with 3 footprint sizes: a circular footprint 40 mm in diameter, a circular footprint 60 mm in diameter, and an elliptical footprint of which the longest length was 120 mm and longest width was 70 mm (Figure 1).

Function of the largest device was studied in 3 mixed-breed dog cadavers of unknown age with body weights ranging from 9 to 12 kg (19.8 to 26.4 lb). A 5-mm ventral midline stab incision was performed 30 mm caudal to the umbilicus, into the abdominal cavity. One stay suture was placed at the cranial end of the incision. The lift retractor was inserted into the defect and rotated 300°, and the retractor was manually lifted. A ventral midline incision was performed from the xyphoid cartilage to the cranial extent of the lift device. The abdominal cavity was inspected through the incision, and engagement of structures other than body wall by the lift was noted, if any. Immediately after lift retraction, a complete necropsy was performed, with care taken to observe the abdominal cavity and organs for postmortem trauma caused by the lift retractors.

**Case selection**—Medical records of the Veterinary Teaching Hospital at Washington State University were reviewed to identify client-owned dogs and cats that had undergone lift laparoscopy. Animals were excluded if an inadequate amount of the required data (approx < 90%) was not recorded in the medical record.

**Data collection**—Medical records were reviewed for information related to signalment, body weight, clinical signs, diagnosis, surgery type and duration, conversion from laparoscopic to open surgery, reason for conversion, preoperative ASA score,\textsuperscript{21} \textit{PET}\textsubscript{CO\textsubscript{2}} during laparoscopy, peak intraoperative \textit{PET}\textsubscript{CO\textsubscript{2}}, mean saturation of hemoglobin with O\textsubscript{2}, mean MAP and SAP during laparoscopy, lowest MAP and SAP during surgery, total anesthesia time, duration of hospitalization, and postoperative complications. In addition, drugs used for premedication, induction and maintenance of anesthesia, and intraoperative analgesia were recorded, along with methods for measuring blood pressure. The decision to administer opioids during surgery to provide additional intraoperative analgesia was made at the discretion of the attending anesthesiologist. Continuous data were summarized as median and IQR (25th to 75th percentiles).

**Surgical procedures**—In the operating room, animals were positioned in dorsal recumbency in a level position or with mild (ie, < 5°) head-down position (ie, a Trendelenburg position). After routine surgical preparation and draping, a 1-cm ventral midline skin incision was made and continued until the rectus fascia was encountered. Two stay sutures of 2-0 or 0 polydioxanone were placed in the linea alba and rectus fascia at the cranial and caudal ends of the incision. Tension was applied to the stay sutures to elevate the linea alba in relation to the abdomen. In the first 2 patients, a gelpi retractor was used for subcutaneous retraction, but in subsequent patients, this was deemed unnecessary. A 5- to 8-mm stab incision into the abdominal cavity was made in the tented linea, and a nerve hook was inserted and used to retract the peritoneum and falciform ligament if they obscured the view of the opening. A custom-made abdominal lift was inserted in the incision and rotated 300° to allow full insertion of the device (Figure 2). The abdominal lift was retracted ventrally, and a standard 30°, 5-mm laparoscope was inserted.
in the same incision as the lift or through a working cannula or trochar placed on the midline 30 to 50 mm caudal to the first incision. The 40-mm-diameter lift was used in cats and dogs that weighed < 5 kg (11 lb), the 60-mm-diameter lift was used in dogs and cats that weighed between 5 and 10 kg (11 and 22 lb), and the 120 × 70-mm elliptoid lift was used in dogs and cats that weighed > 10 kg. Additional trochars were placed as needed during direct visualization with the laparoscope. The lift was continually elevated by means of manual retraction or by attaching it to a custom-made lift hook with adjustable length that was suspended from a hanging IV stand positioned immediately above the patient’s abdomen.

Surgical procedures were performed as described. 

**Results**

**Cadaver study**—In all 3 cadavers, the lift device was positioned in contact with the parietal peritoneum. The lift device did not penetrate any abdominal organs or lift the omentum in any of the dogs. The falciform ligament was not penetrated by the device but was retracted to the left side of the abdomen. Necropsy did not provide any gross evidence of trauma associated with the lift device; histologic examination of the lift-engaged portion of the abdominal wall was not performed.

**Animals**—Seven dogs and 5 cats that underwent lift laparoscopy between November 2008 and September 2009 were eligible for inclusion in the study. The dogs included a 4-month-old 10-kg mixed-breed female with severe unifocal idiopathic ventricular arrhythmia that underwent ovariohysterectomy (Figures 3 and 4), a 1-year-old 25-kg (55-lb) spayed female Labrador Retriever with a peritoneopericardial diaphragmatic hernia that underwent herniorraphy, a 10-year-old 36-kg (79.2-lb) spayed female Labrador Retriever with hepatothopathy that underwent hepatic biopsy, a 5-year-old 49-kg (107.8-lb) spayed female Leonberger with chronic intermittent gastric dilatation that underwent gastropexy, a healthy 8-year-old 28-kg (61.6-lb) Standard Poodle that underwent prophylactic gastropexy, an 8-month-old 28-kg Scottish Deerhound with unilateral cryptorchidism and factor VII deficiency that underwent cryptorchidectomy, and a 3-year-old 8-kg (17.6-lb) male Dachshund with pancreatitis, extrahepatic bile duct obstruction, and disseminated intravascular coagulation that underwent exploratory surgery and jejunostomy tube placement. The cats included 3 spayed female domestic shorthair cats (4, 12, and 13 years of age weighing 5, 6, and 13 kg [11, 13.2, and 28.6 lb], respectively) with gastrointestinal tract disease or suspected intestinal lymphoma that underwent gastrointestinal tract biopsy, a 7-year-old 5-kg spayed female domestic shorthair with uroliths that underwent cystotomy and urolith removal, and a 4-year-old 5-kg castrated male Siamese with uroliths and cystitis that underwent cystotomy. Median age of the dogs was 3 years (IQR, 0.8 to 6.5 years), and median age of the cats was 7 years (IQR, 4 to 12 years). Median age of all animals was 4.3 years (IQR, 2.5 to 8.5 years). Median body weight of the dogs was 27.3 kg (60.5 lb; IQR, 17.3 to 31.8 kg [38.1 to 70.0 lb]), median weight of the cats was 5 kg (IQR, 5 to 5.4 kg [11.0 to 11.9 lb]), and median weight of all animals was 8.6 kg (17.2 lb; range, 5.3 to 27.6 kg [11.7 to 60.7 lb]).

**Clinical and surgical findings**—Four of the 5 cats had ASA scores assigned preoperatively; all 4 had a preoperative ASA score of 2. Six of the 7 dogs had ASA scores assigned preoperatively; 2 had a preoperative ASA score of 1, 1 had an ASA score of 2.5, 2 had an ASA score of 3, and 1 had an ASA score of 4. Median value for mean intraoperative respiratory rate was 10 breaths/min (IQR, 8 to 15 breaths/min), median value for mean PETCO2 during laparoscopy was 32.4 mm Hg (IQR, 29.8 to 34.1 mm Hg), median value for peak intraoperative PETCO2 was 38 mm Hg (IQR, 33.5 to 40.3 mm Hg), median value for mean saturation of hemoglobin with O2 was 95.1% (IQR, 94% to 95.8%), median value for mean intraoperative MAP was 75 mm Hg (IQR, 65 to 80 mm Hg), median value for lowest intraoperative MAP was 60 mm Hg (IQR, 33 to 65 mm Hg), and median value for mean intraoperative SAP was 90 mm Hg (IQR, 84 to 106 mm Hg). Blood pressures were measured directly in 3 patients, with an indirect oscillometric method in 7 patients, and with direct and indirect methods in 2 patients. In the

---

**Figure 3**—Photograph of the cranial portion of the abdomen in a dog undergoing lift laparoscopy for ovariohysterectomy. The falciform ligament (not shown in image) has been retracted to the left by the lift device.

**Figure 4**—Photograph of left side of the abdominal cavity in a dog undergoing lift laparoscopy for ovariohysterectomy. Notice the fat surrounding the ovarian bursa (arrow). The colon has been retracted out of the image.
latter 2 patients, medical records did not specify which values were obtained by use of each method.

Surgical time ranged from 90 to 125 minutes for the 3 cats that underwent multiple gastrointestinal tract biopsy (conversion to laparotomy was necessary in 1 of the 3 cats) and was 60 and 155 minutes for the 2 cats that underwent cystotomy and urethral removal. Surgical time was 65 minutes for the dog that underwent ovariohysterectomy, 120 minutes for the dog that underwent hemorrhaphy (conversion to laparotomy was necessary), 40 minutes for the dogs that underwent hepatic biopsy, 80 and 85 minutes for the 2 dogs that underwent gastropexy, 75 minutes for the dogs that underwent cryptorchidectomy, and 105 minutes for the dog that underwent exploratory surgery and jejunosotomy tube placement. Median total anesthesia time was 179 minutes (IQR, 139 to 199 minutes), and median time that anesthesia time exceeded surgical time was 71 minutes (IQR, 57 to 91 minutes).

In 2 of the 12 animals, conversion from lift laparoscopy to laparotomy was required. One of these animals was a cat in which laparoscopic gastrointestinal biopsy was attempted even though the cat underwent gastroenteroscopy immediately prior to surgery. In this cat, the gastrointestinal tract was distended with gas, and the lack of an appropriate visual field was deemed incompatible with a safe laparoscopic procedure. The other animal in which conversion was required was a dog undergoing correction of a peritoneopericardial diaphragmatic hernia in which the entire jejunum, ileum, and cecum had herniated into the thoracic cavity. In this patient, the decision to convert to a laparotomy was made on the basis of poor visualization of the hernia because of its ventral location in combination with slow progression in repositioning the herniated intestines into the abdominal cavity.

The dog with pancreatitis, extrhepatic bile duct obstruction, and disseminated intravascular coagulation that underwent exploratory surgery and jejunosotomy tube placement did not receive general anesthesia during laparoscopy. The dog was in a stuporous condition when laparoscopic jejunosotomy tube placement was requested for nutritional support and received a continuous IV fentanyl infusion during the procedure. The dog’s condition improved transiently after surgery, but the dog was euthanized 8 days later. Intraoperative opioid analgesia was provided in 9 of the 11 animals.

Outcome—Median hospitalization time after surgery was 2 days (IQR, 1 to 2 days). One dog was euthanized 8 days after surgery. The remaining animals were hospitalized for 0 (n = 1), 1 (4), or 2 (6) days. No complications relating to surgery were reported.

Discussion

Results of the present study suggested that lift laparoscopy is feasible in dogs and cats and is an option that can be used in clinical practice, especially if creation of positive-pressure pneumoperitoneum is undesirable. Routinely assessed clinical variables were not negatively affected by this technique. In the preliminary cadaver study, it was noticed that the falciform ligament did not appear to have been traumatized by the device and that the risk of organ trauma appeared low. The advantageous retraction of the falciform ligament noticed in the cadavers, however, was not consistently seen in the clinical cases, and clinicians should be aware that the falciform ligament may obstruct the visual field during lift laparoscopy. Our results are in agreement with results of a recent meta-analysis of studies in human medicine, which concluded that the abdominal lift technique is safe for use in clinical surgical practice. The meta-analysis also concluded that the lift technique decreases the cardiopulmonary changes observed with laparoscopic cholecystectomy.

However, most of the patients in these previous studies were relatively healthy, with preoperative ASA scores of 1 or 2. Four of 6 dogs in the present study had an ASA score > 2, and no adverse changes were identified in respiratory or hemodynamic variables in these dogs, indicating that the lift technique appears to also be safe in dogs and cats. However, a larger number of patients must be studied before definitive conclusions can be drawn.

In the previous meta-analysis, surgical time was greater in human patients undergoing lift laparoscopy, which was at least in part due to poorer exposure. Surgical times for cholecystectomy in the 13 studies that were the basis for the meta-analysis ranged from 65 to 121.3 minutes in patients that underwent lift laparoscopy and ranged from 62 to 114 minutes in patients that underwent conventional laparoscopy. The differences between these studies demonstrate the difficulties associated with comparing surgical times between surgery centers. However, 9 of 13 studies had a mean additional time ranging from 3 to 24 minutes for lift laparoscopic cholecystectomy, compared with conventional laparoscopic cholecystectomy.

Four studies found that lift laparoscopic cholecystectomy required a mean of 8 to 11 minutes less than conventional laparoscopic cholecystectomy. In the present study, median surgical time with lift laparoscopy appeared long, but a prospective study is necessary to determine whether it is comparable to times associated with conventional laparoscopy. The most common laparoscopy-assisted surgical procedures in the present study were multiple gastrointestinal tract biopsy (n = 3), gastropexy (2), and cystotomy (2). Surgical time for the 1 dog that underwent hepatic biopsy was 40 minutes, which seems long for a simple diagnostic procedure. Lift laparoscopic ovariohysterectomy required 65 minutes in the 1 dog in which it was performed in the present study; by comparison, previously reported surgical times range from 21 minutes to 120 minutes. However, it is worth noting that, in the present study, surgical times included closure of the incisions, which is typically performed by students at our institution, and closure time was often longer than 15 minutes. In addition, although surgical procedures were performed by a board-certified surgeon, resident training was also taking place, which likely prolonged surgical time. Also, in the first few patients, great efforts were made to visualize the abdominal cavity prior to insertion of the lift. Stay sutures were placed, which added to the surgical time. With increased use of the lift device since the present study, we have now discontinued placement of stay sutures because they seem to be unnecessary. When the falciform ligament is encountered, the lift is rotated into place without further attempts at visualization. Future studies are needed to determine whether surgical times are indeed prolonged with lift laparoscopy, compared with times for conventional laparoscopy.

Subjectively, lift laparoscopy was associated with slightly poorer visualization of the abdominal cavity in the present study. The lateral aspects of the abdominal cavity were especially harder to expose because of the tenting ef
fect of the retractor, in contrast with the dome-like shape of the abdominal wall during conventional laparoscopy with pneumoperitoneum. However, for most applications, we thought that the lift device provided adequate visualization when an appropriately sized lift was used. The lifting tension is likely directly related to visualization. This factor was not assessed in the patients described in the present report, but will be studied in future investigations. We used the minimum amount of tension required for visualization of the target organs. However, in many patients, the required tension was subjectively perceived to be quite high, especially during particular stages in the procedures, such as localization of the ovaries. Lift laparoscopic ovariohysterectomy led to no difficulties in localization of the ovaries, despite the fact that a lateral tilting device was not used, and the entire procedure was performed with the dog in dorsal recumbency. Visualization may be more negatively affected when lifting with the dog in lateral recumbency because of the exaggerated tenting effect of the lateral abdominal wall. It is possible that adjunctive or additional lifting devices could be advantageous for visualization, especially in larger animals.

In 1 cat and 1 dog that underwent lift laparoscopy in the present study, conversion to laparotomy was required. In the cat, conversion was required because of poor exposure related to the air-filled intestinal segments and large omental fat deposits. In this cat, the laparoscopic approach could potentially have been more successful if the procedure had been postponed until air that had been insufflated into the stomach and intestines had resolved. However, the owner requested conversion to open surgery to ensure that all procedures were performed during a single anesthetic episode. In the dog, conversion was required in part because of poor exposure. However, the main indication for conversion was the finding that repositioning herniated organs into the abdominal cavity was time-consuming, and it was perceived that the surgery was not progressing with the desired efficacy. This was the first time any form of diaphragmatic hernia had been operated on with laparoscopic techniques at our institution because diaphragmatic defects are generally considered contraindications for conventional laparoscopy. Lift laparoscopy provides an opportunity to explore diaphragmatic hernias, but techniques for organ repositioning without the aid of digital palpation and traction need to be further investigated to provide an efficacious laparoscopic approach.

In patients in the present study in which multiple biopsy specimens were obtained, there were considerable practical advantages to the use of lift laparoscopy. Specifically, there was no need for reininsufflation of the abdomen between biopsy sites, and instruments of different sizes could be used without the need to insert working cannulae with valves. In this respect, lift laparoscopy much resembles laparoscopic thoracoscopy, which is also performed with simple, nonvalved cannulae.

In the present study, the abdominal wall lift tension was not determined, and to our knowledge, the lift tension required for optimal visualization has not yet been determined. Also, at present, there is limited understanding of the peritoneal reaction to the lift itself or whether such trauma would be directly related to lift tension. Studies have concluded that the degree of surgical stress, as determined by measuring inflammatory cytokine concentrations, is no greater with lift laparoscopy than with conventional laparoscopy with CO₂ insufflation. To our knowledge, increased adhesion formation as a result of peritoneal trauma has not been associated with abdominal wall lift laparoscopy in humans. In contrast, insufflation of room-temperature, nonhumidified CO₂ has experimentally been shown to lead to increased adhesion formation, compared with adhesion formation following insufflation of heated, humidified CO₂.

There are several limitations to the present study. First, retrospective clinical studies such as the present study are subject to incomplete data recording. Certain data were not collected in some patients because the attending anesthesiologist did not consider them indicated. For example, intraoperative arterial blood gas analysis was performed in only 1 patient. Second, a standardized protocol for pain assessment and treatment was not used. Thus, pain severity could not be assessed. Third, the retrospective study design led to a lack of measurements requiring invasive procedures, such as placement of a Swan-Ganz catheter for measurement of cardiac output. Fourth, the number of animals included in the present study was low, and cardiopulmonary effects of lift laparoscopy were not compared with those of conventional laparoscopy. Even with these limitations, however, results of the present study encourage further use of lift laparoscopy in dogs and cats, which may lead to accumulation of larger numbers of cases from multiple surgical centers, greatly increasing our understanding of this new laparoscopic technique.

### References