With the advent of natural orifice transluminal endoscopic surgery, attempts are being made to minimize external skin incisions in both human and veterinary laparoscopy. The single-port entry platform (by consensus termed the LESS platform) is a potential intermediate step toward natural orifice transluminal endoscopic surgery. Laparoendoscopic single-site surgery is an advanced minimally invasive operative approach in which procedures are performed laparoscopically via a single small (ie, 12- to 15-mm) abdominal incision. The emergence of this platform has led to the development of advanced surgical techniques that use novel medical devices, including an array of commercially available multitrocar access ports and articulating laparoscopic instruments. The LESS platform uses these novel devices to recreate the basic sense of triangulation and surgical working space encountered with traditional multiport laparoscopy.

As with most novel surgical techniques that use newer technology, longer operative times and more procedure-related complications are expected to be associated with the early stages of the learning curve. In human patients, the early implementation of the multiport laparoscopic cholecystectomy introduced in the late 1980s caused a profound impact on the way minimally invasive surgery was incorporated into mainstream surgery. The learning curve for surgeons using this multiport laparoscopic technique was evaluated in various reports. Only 1 report in the veterinary literature discusses the LESS technique for ovariectomy in dogs.
Currently no published reports describe LESS canine ovariectomy with a multitrocar port with articulating instruments and an angled telescope. The purpose of the study reported here was to describe the surgical technique of LESS ovariectomy with a commercially available multitrocar port with articulating instruments and an angled telescope, define the learning curve for LESS ovariectomy for an experienced laparoscopic surgeon, and evaluate patient outcome.

**Materials and Methods**

**Dogs**—Medical records of client-owned sexually intact female dogs that underwent an LESS ovariectomy between April 2011 and December 2012 at the Matthew J. Ryan Veterinary Hospital of the University of Pennsylvania were reviewed. Dogs were included if the medical record was complete, the procedure was performed by the same primary surgeon (JJR), and the procedure used the same type of commercially available multitrocar access device combined with articulating instruments and a 30° telescope. All owners were informed of the possible need for additional port placement or the need to convert to an open celiotomy if the surgery proved difficult or complications developed. Signalment, including breed, age, and weight, was recorded. Operative data, including the surgery time (from the first incision to application of last closing suture), size of the incision, location of port placement, and need for conversion (both to standard multiport laparoscopy and to open celiotomy), were documented. The occurrence of intraoperative complications, including subjective blood loss or tissue injury, was also recorded. Short-term (14 to 21 days) postoperative follow-up was available for all patients.

All procedures were performed by the same primary surgeon (JJR), who was a board-certified surgeon with advanced training in laparoscopy, expert-level laparoscopic ability (ie, primary surgeon in >100 laparoscopic procedures/y), and previous substantial clinical experience with 2- and 3-port laparoscopic ovariectomy.

**Anesthetic and analgesic protocol**—All dogs were premedicated in accordance with a protocol approved by the attending hospital anesthesiologist. In all dogs, anesthesia was induced with propofol administered to effect (up to a maximum of 10 mg/kg [4.5 mg/lb], IV) prior to endotracheal intubation. All dogs were maintained under general anesthesia with an inhalation anesthetic (either isoflurane or sevoflurane in oxygen).

**Surgical technique**—Following standard aseptic abdominal preparation, with dogs positioned in dorsal recumbency, a 1.5- to 2.0-cm skin incision was made sharply at the level of the umbilicus with a scalpel. The incision was continued through to the deeper tissues with a combination of monopolar cautery and sharp dissection, to incise the linea alba. The peritoneum was then incised at this location, creating a full-thickness 1.5- to 2-cm abdominal incision. A multiple access port was inserted into the incision at this site by clamping 2 curved Rochester-Carmalt forceps at the base of the soft multitrocar port in a staggered manner (Figure 1). The base of the port was coated with a liberal amount of sterile lubricant to aid in insertion. The fascial edges of the linea alba were grasped with 2 large rat-toothed tissue forceps to provide the necessary countertraction during port insertion. The tips of the Carmalt forceps clamped to the multitrocar port were then inserted through the incision and directed toward the xiphoid. The curved Carmalt forceps were used to fit the bottom half of the multitrocar port snugly within the incision. The Carmalt forceps were then released to allow the bottom portion of the port to expand within the incision. The three 5-mm cannulae supplied with the multitrocar port were then inserted into 3 corresponding holes within the multitrocar port with the aid of the supplied 5-mm blunt obturator (Figure 2). A small amount of sterile lubricant was applied to the ends of the obturator to facilitate insertion of the cannulae into the multitrocar port. The heights of the 3 cannulae were then staggered by inserting them at different depths into the port, causing the cannula heads to be uneven in a horizontal plane. Insufflator tubing was then attached to the multitrocar port’s insufflator attachment and turned on to establish pneumoperitoneum. The abdomen was then insufflated by use of carbon dioxide with a pressure-regulating mechanical insufflator. Intra-abdominal pressure was maintained...
between 8 and 10 mm Hg. A 5-mm 30° telescope was inserted into one of the 5-mm cannulae to view the abdomen for preliminary exploration.

With the surgeon standing on the right side of the patient, the multitrocar port was rotated to have the cannulae facing the surgeon in the 2, 6, and 10 o’clock positions. Then, with a mechanical tilt, the table was tilted 30° to 45° to the dog’s right side. The telescope was then positioned through the 10 o’clock cannula, and the 5-mm articulating grasper was subsequently passed through the 6 o’clock cannula. The telescope and the articulating grasper were directed toward the left ovary. The tip of the articulating grasper was then deflected in a 90° direction relative to the shaft of the instrument toward the left ovarian proper ligament (Figure 3). The proper ligament was then grasped and suspended with the deflected tip of the articulating instrument and held stationary by the surgical assistant. The light post of the 5-mm 30° telescope was then rotated so the camera head was positioned away from the multitrocar port. A 5-mm bipolar vessel sealing device was then inserted through the 2 o’clock cannula and directed to the suspended left ovary. The ovariectomy was completed by first sealing then dividing the ovarian artery and ovarian vein, followed by the mesovarium including the suspensory ligament, and then directed to seal and divide the tissue caudal to the proper ligament. Once the ovarian tissue was free of all remaining attachments and hemostasis was confirmed, the vessel-sealing device was removed from the multitrocar port. The articulating grasper was then straightened within the abdomen while maintaining a firm grasp on the excised ovarian tissue. With the articulating grasper still holding the excised ovary, the instrument was retracted to bring the ovary flush to the inner portion of the multitrocar port. Then, the camera and its associated cannula were removed. The automatic insufflator was turned off, and the cannula for the vessel-sealing device was removed. With the articulating grasper still remaining through the multitrocar port, the external soft edge of the multitrocar port was grasped digitally and removed from the abdominal incision. During this multitrocar port removal, the articulating grasper maintained its grasp of the ovary on the inside of the margin of the multitrocar port. Once the left ovary was removed, the dog was then returned to dorsal recumbency and the multitrocar port was reinserted as described.

The surgeon then moved to the left side of the dog. The dog was then tilted to the left, and the cannulae were inserted and rotated to the 2, 6, and 10 o’clock positions. The right ovary was then removed in the same manner as for the left ovary (Figure 2).

When difficulty was encountered in exposing the ovarian tissue owing to coverage of the intestinal tissue, omentum, mesentery, or spleen, an additional articulating instrument was placed through the multitrocar port. The 2 articulating instruments were entered through the 2 and 10 o’clock cannulae, and the telescope was placed through the 6 o’clock cannula with the light post directed ventrally. The surgeon used the 2 articulating instruments for the cross-handed technique, in which the instruments crossed internally with the tips deflected toward each other, while the assistant held the camera (Figure 4).

All procedures were completed with the primary surgeon manipulating the vessel sealing device and the telescope, with the grasper being intermittently positioned by the primary surgeon as needed. Once the primary surgeon grasped the tissue with the articulating grasper, it was passed off to the assistant for static retraction. When both ovaries were removed, the 1.5- to 2.0-cm multitrocar port site was closed with size-0 polydioxanone for the linea alba in a continuous pattern, with 3-0 and 4-0 poliglecaprone 25 in a continuous pattern for the subcutaneous and the intradermal layers, respectively.

Figure 3—Representative photograph of the tip of an articulating grasper deflected 90° relative to the shaft of the instrument.

Figure 4—Representative photograph of 2 articulating instruments held so they cross internally with the tips deflected toward each other, as they would be used in a cross-handed technique during LESS ovariectomy in a dog.
Postoperative care—After surgery, each patient was monitored in the hospital for 12 to 24 hours. Buprenorphine (0.01 mg/kg [0.0045 mg/lb], IV, q 4 to 6 h) was administered in the hospital for postoperative analgesia. All dogs were discharged either the same day of or the morning after surgery and prescribed 4 days of either deracoxib (2 mg/kg [0.91 mg/lb], PO, q 24 h), carprofen (2.2 mg/kg [1.0 mg/lb], PO, q 12 h), or firocoxib (5 mg/ kg [2.3 mg/lb], PO, q 24 h).

Follow-up—Follow-up information was obtained at a 14-day postoperative visit or, when this was not possible, via a telephone conversation with the owner approximately 14 to 21 days after surgery. Information obtained at the time of follow-up included the occurrence of any postoperative complications, specifically focusing on incisional concerns including discharge, seroma formation, or dehiscence. Owners were surveyed on their overall satisfaction with the LESS ovariectomy procedure and whether they would pursue the procedure again.

Statistical analysis—The number of days between successive surgeries was calculated with the date function in statistical software to establish a point of reference for subsequent reporting. Dates of surgeries were sorted, and the number of days between successive surgeries was determined. To investigate skill acquisition, an exponential form model mimicking the ideas of Chomsky in regard to the learning process was used:

\[ t = ae^{-bSn} + c \]

where \( e \) is the base of the natural logarithm, \( Sn \) is the ordinal case number, \( t \) is the predicted surgery time (minutes) for case \( Sn \), \( c \) is the asymptote (or optimal surgery time), \( a \) is the (theoretically unlearned) initial surgery time above the asymptote, and \( b \) is the exponential rate of improvement (reduction) of surgery time with each additional case. Note that in this form, \( a + c \) is the \( y \)-intercept.

With this model, we can, for example, estimate the number of exposures necessary to achieve a specified fraction of the optimal surgery time (mathematically, \( t \) tending to \( c \) from \( a \)). However, a trivial simplification to the equation reducing the complexity of such determinations with absolutely no changes in the results is to note that whereas the asymptote \( c \) is needed for data fitting purposes, it can be actually dropped from further considerations because its contribution to the learning profile is invariant.

If we set our target surgery performance time to a fraction \( \alpha \) of the optimal performance, then our time for such a surgery will be \((1 - \alpha)a\). For example, if we set our target to 90% of the optimal performance time, then our time to such a performance would be 0.1a. This reflects a drop in surgery execution time from \( a \), the initial theoretical execution time, to 0.1a above the asymptote, \( c \). With this target, we can calculate the number of surgeries it would take to reach (statistically speaking) that performance time, and our answer would be the following:

\[ Sn_\alpha = \frac{-\ln(1 - \alpha)}{b} \]

In addition to simplicity, there are other compelling features of our surgery learning model. First, it is monotonic and thus includes no (exotic) learning features such as inflections, as would be suggested by a learning model embracing Locke's blank plate model, or in connection with addressing other nonlinear aspects of the process in the accumulation of a skill. Second, the model is parsimonious. It includes just one parameter for height (\( a \)), one for the asymptote (\( c \)), and one for curvature (\( b \)), and unless data or philosophy contradicted the fit, this is likely an appropriately modest first foray into the exploration of modeling the process of learning a surgical skill. Third, the function implies diminishing returns from efforts to acquire the skill. Later exposures yield lower skill enhancement than earlier ones. Indeed the slope of the curve at exposure point \( Sn \) is \(-abe^{abc} \). Both the negative sign and the persistently reducing magnitude are in agreement with the data at hand and Chomsky's concept of task readiness in the learning process.

To fit the model to the surgery data, we used a weighted nonlinear least squares with a modified Gauss-Newton algorithm. The modification was to facilitate the automatic switching between the steepest descent method and Newton's method as convergence looms, thus capitalizing on the respective advantages of each approach. The weighting system used was inverse observation weighting. This assures that the emphasis of small and large observations on the converged solution is not excessively influenced by either extreme. This approach was pioneered by tracer kineticists and pharmacokineticists precisely for this purpose. To assess the potential influence of dog weight (size) on our outcome of interest (surgeon performance time, and our answer would be the following:)}
surgery time), we explored the possibility of an association between surgery completion time and dog weight with ordinary regression methods. To validate our application of normal distribution methods in regard to reporting of 95% CIs, we tested the normality of our data by means of the Shapiro-Wilk test. Statistical software programs were used for the investigation. Values of \( P \leq 0.05 \) were considered significant.

**Results**

**Signalment**—Twenty-seven dogs met the inclusion criteria for this study. Median body weight was 20 kg (44 lb; range, 3.5 to 41 kg [7.7 to 90.2 lb]); median patient age was 314 days (range, 176 to 2,913 days). Dog breeds represented for this study were mixed breed (n = 5), Golden Retriever (3), Rhodesian Ridgeback (3), Labrador Retriever (3), Australian Shepherd Dog (2), Doberman Pinscher (1), Beagle (1), Brittany Spaniel (1), Cane Corso (1), Cocker Spaniel (1), German Shepherd Dog (1), Saluki (1), Shih Tzu (1), Standard Poodle (1), Vizsla (1), and West Highland White Terrier (1).

**Operative data**—Median surgical time (from the start of the skin incision to placement of the last suture) was 35 minutes (range, 20 to 85 minutes); Mean time between surgical procedures was 22.2 days (median, 9.5 days [range, 0 to 142 days]; interquartile range, 5 to 24 days).

**Model fitting**—A curve was fit to the surgery skill acquisition data set for 35 surgeries (2 statistical outliers removed; Figure 3). Information assembled in connection with the fitting process was summarized (Table 1). We present examples of estimates of the number of surgeries required to achieve certain close proximities of the optimal performance time (Table 2). The surgery time required for a specified fraction, \( \alpha \), of the optimal surgery time is denoted \( t_\alpha = c + (1 - \alpha) a \). By adding \( c \) to \( (1-\alpha)a \), we admit the unachievable, but invariant, time component of our estimates. According to the Chomsky-style skill acquisition model, approximately 8 (\( S_{n_0} \)) procedures (95% CI, 0.5 to 16.6 procedures), an experienced surgeon would be expected to reach 90% \( (\alpha = 0.1) \) of the optimal surgical performance time expected (Table 2). After 11 (\( S_{n_0} \)) procedures (95% CI, 0.7 to 21.6 procedures), a surgeon would be expected to reach approximately 95% \( (\alpha = 0.05) \) of the optimal surgery performance time expected. After 17 (\( S_{n_0} \)) procedures (95% CI, 0.0 to 31.3 procedures), a surgeon would be expected to reach 99% \( (\alpha = 0.001) \) of the optimal surgery performance time expected (Table 2). According to the model, with each surgery, surgical time would be expected to decrease by 27% (95% confidence interval, 2% to 52%). The asymptotic best surgery time (the theoretical fastest surgery time beyond which no further improvement would be expected) was estimated to be 30 minutes (95% CI, 25.86 to 33.86 minutes).

There was no significant \( (P = 0.665) \) association between surgery completion time and dog weight. Data were assessed by means of the Shapiro-Wilk test and found to be normally distributed \( (P > 0.05) \).

**Complications**—Minor complications occurred in 2 of the 27 cases. One dog had an intraoperative complication. This dog had a splenic laceration that occurred during initial multitrocar port insertion when the sharp leading edge of the 5-mm cannula was inserted through the multitrocar port. Hemorrhage was noted when the telescope was inserted into the abdomen. In this dog, a hemo-static cellulose polymer was applied directly to the spleen under direct observation through the 2-cm abdominal incision with the multitrocar port removed. Once hemostasis was achieved, the multitrocar port was reintroduced and LESS ovariectomy was successfully completed. One dog had a postoperative incisional infection noted when discharge from the wound was observed by the owner 12 days after surgery. This dog was found to be licking the incision. This complication resolved with a 14-day course of antimicrobial treatment with amoxicillin potentiated with clavulanic acid (13.75 mg/kg [6.25 mg/lb], PO, q 12 h).

**Postoperative short-term follow-up**—Fourteen-day, short-term postoperative follow-up was available on all 27 cases through either a direct hospital examination or a telephone conversation with the owner. Information obtained at the time of follow-up indicated that 1 of the 27 cases had an incisional postoperative infection. In all cases, owner satisfaction was high, with all owners disclosing they would pursue the LESS ovariectomy again.

**Discussion**

In the present study, the learning curve for LESS ovariectomy in dogs performed by an experienced board-certified laparoscopic surgeon was short and definable. The skill acquisition model revealed that a comparable surgeon may be anticipated to reach 95% of the optimal surgical performance expected after 11.1 procedures (95% CI, 0.7 to 21.6 procedures). Results of this study suggested that an experienced laparoscopic surgeon could achieve proficiency with the LESS ovariectomy technique after...
performing 8.6 procedures (90% of the optimal surgery performance time expected [95% confidence interval, 0.5 to 16.6 procedures]). Two of 27 patients developed minor complications, which resolved with treatment, and at the time of short-term follow-up (between 14 and 21 days after discharge), all owners were satisfied with the LESS ovariec-tomy procedure.

With the single-port platform, the principle that all laparoscopic instruments, including the telescope, be introduced simultaneously through the same access point in the abdominal wall is maintained. Use of this platform in the veterinary surgery has increased substantially in the past several years, with descriptions of its application for an array of minimally invasive abdominal procedures. A recent report described a European group's initial experience with a commercially available multitrocar port for canine ovariec-tomy; although that group used the same multitrocar port as the one used in the present study, they reported an alternative surgical technique that involves the use of different laparoscopic instrumentation. They described ovariec-tomy completed with standard rigid laparoscopic instrumentation, a transabdominal suspension suture, and a 10-mm vessel sealing device. Those authors experienced limitations in instrument triangulation, a general restriction in instrument motion, and a subjective increase in collision between the instruments and telescope when the transabdominal suture was not used in the procedure. That group also completed the procedures with a 0° telescope. With the technique used in the present study, we were able to circumvent many of the technical difficulties encountered in the European study by use of designated single-port instrumentation and by modifying the surgical technique to accommodate only a single site of abdominal entry.

With single-port surgery, the use of rigid straight instru-ments results in an evident loss of instrument triangula-tion, causing instrument crowding and restricted range of motion internally and externally. Fortunately, the develop-ment of novel bent and articulating instruments intended for single-port procedures allows surgeons to avoid these issues. In the present study, the use of these instruments combined with an angled telescope efficiently reproduced the working space and triangulation experienced with standard multiport laparoscopy and also alleviated the difficulties reported with standard rigid instrumentation in single-port surgery. When using articulating instruments combined with a 30° telescope, we were able to increase instrument triangulation and also improve the internal working space within the canine abdomen. Use of the 30° telescope enabled the camera head to be positioned away from the other instru-ments that were simultaneously passed through the multi-trocar port. Because our technique enables 2 instruments and a telescope to be inserted simultaneously through the multitrocar device, we were ultimately able to eliminate the need for a transabdominal suspension suture as described for other methods for canine ovariec-tomy. The articulat-ing instrumentation and angled telescope eliminated intra-abdominal instrument clashing and subjectively reduced extra-abdominal instrument handle clashing. The articula-tion of the instruments allowed the tip of the instrument to deflect freely in 180° of movement relative to the shaft of the instrument (Figures 3 and 4), in effect giving the surgeon a wrist-like motion on the instrument tip within the abdomen. This articulation and tip deflection reduced internal instru-ment interference and provided an unobstructed pathway for the bipolar vessel–sealing device to reach the targeted tis-sue. Because deflection of the tip toward the tissue causes the handle to be deflected in the same direction, the surgeon's hands are then positioned away from the other instruments passing through the multitrocar port. Another major benefit we encountered when using the multitrocar port was that the port could be easily inserted and removed from the abdomen repeatedly during the procedure. This enabled the ovarian tissue to be removed immediately after it was freed from its visceral attachments before moving to the contralateral ovary. This technique of removing the ovary from the abdomen be-tween sides has not been reported in the veterinary literature.

Complications observed in this study were mi-nor, with the intraoperative complication in 1 patient occurring from an iatrogenic splenic laceration dur-ing initial multitrocar port insertion. Splenic injuries have been reported in dogs during laparoscopic proce-dures. Splenic injury has been reported with use of the multitrocar port during initial port insertion in single-incision laparoscopic ovariec-tomy in dogs and during single-port gastropexy and ovariec-tomy in dogs. To prevent this type of injury, digital countertraction was placed on the multitrocar port during any cannula insertion. In addition to traction, we found that inserting the 3 can-nulae partially through the multitrocar port (tips not passing the inner margin of port) prior to abdominal insuffla-tion minimized damage to underlying abdominal viscera. Once the abdomen was fully insufflated, the cannulae could then be fully inserted into the multitrocar port.

In the present study, operative time was the primary metric for evaluating skill acquisition; this was based on a previous study that defined learning curves for LESS cho-lecytectomy in human patients. We fit a model for skill acquisition associated with procedural time for a single experienced laparoscopic surgeon (Figure 5). The curve falls monotonically from approximately 60 to 30 minutes, suggesting that from the start of the learning process, a reduc-tion of approximately 30 minutes of procedural time can be negotiated before the optimal operative time is achieved. The asymptote depicted in the model represents an optimal surgical performance time of approximately 30 minutes. From the skill acquisition model (Table 2), we found that it would take 8.6 surgeries to achieve 90% of the surgeon's optimal surgery time, 11.1 surgeries to achieve 95% of the surgeon's optimal surgery time, and 17.1 surgeries to reach 99% of the surgeon's optimal surgery time.

Unexpected delays occurred in 2 surgeries. In one of these cases, the surgical team experienced equipment failure unrelated to the surgical procedure. In the other case, surgical progress was temporarily paused because of the need to address temporary splenic hemorrhage. This hem-orrhage occurred during port insertion, as a result of inade-quate communication between the primary surgeon and assistant surgeon during cannula insertion. One of the can-nulae being inserted by the primary surgeon subsequently caused splenic trauma as a result of an inadequate amount of port countertraction during initial multitrocar port place-ment. With appropriate countertraction of the port during initial insertion, no further incidents of this type occurred in all subsequent cases. During both delayed procedures, the extended surgery time was caused by components not associated with the act of performing the procedure by the
primary surgeon, but by external factors that could have been avoided if equipment had not malfunctioned and if the same surgical assistant was present for all procedures or surgical team communication was improved (ie, the target of the statistical analysis). Additionally, it was found that the 2 observations were statistical outliers (data not shown).

Studies of surgical learning curves in humans for common techniques such as laparoscopic cholecystectomy have used operative time as a metric for learning curve modeling. We chose to follow similar methods to determine whether a commonality existed between our findings and previous reports. Authors of human reports estimate it would take approximately 10 to 30 procedures for an advanced laparoscopic surgeon to achieve proficiency with multipoort cholecystectomy. With the recent introduction of the LESS platform in humans, similar learning curves have been developed for LESS cholecystectomy.

In humans, the LESS cholecystectomy was found to be a safe procedure, and the learning curve was definable and short, with an experienced surgeon beginning near proficiency; however, this experienced surgeon had the ability to improve, indicating one can become even more proficient after performing approximately 20 procedures.

Although LESS ovariotomy in dogs is an entirely different procedure and considerably less complex than LESS cholecystectomy in humans, our findings were similar in that we estimated that an experienced laparoscopic surgeon would be able to achieve proficiency after performing only a few surgeries and that the risk of major complications was low. Further studies are needed to evaluate whether these findings are valid for other experienced board-certified veterinary surgeons. Interestingly, the European veterinary study did not reveal any significant differences in surgery time between the first and last procedure performed. The reasons cited for not observing improvement were that the sample population may not have been large enough and that the 10-mm vessel sealing device used for the ovarian resection may have been very efficient in leveling the mean time for ovarian resection. Our results were based on the use of a slightly different technique and, contrary to the findings in that report, indicated a noticeable decrease in overall procedural time.

As with most novel surgical techniques involving newer technology, increased operative times and procedure-related complications might be expected during early implementation. Evaluation of a surgeon’s learning curve for a newer surgical procedure enables prediction of how a similarly qualified surgeon could master that surgical procedure. A learning curve illustrates how performance of a task improves with repetition over time. In the surgical arena, the benefit of evaluating learning curves is that it would be theoretically possible to estimate how long it would take a surgeon to become proficient, predict how and when complications may occur, and potentially give an estimate of the optimal surgical time that might be reached.

The surgeon in this investigation had advanced training in laparoscopy and would otherwise be categorized at an expert level. It is highly likely that skills acquired through previous experiences in laparoscopy were retained and influenced the learning process of LESS ovariotomy. Results from this investigation may not be a true representation of what a novice surgeon would experience. Further evaluation of the procedure performed by surgeons with various levels of training is necessary to give an accurate representation of the differences that may exist for novice practitioners.

Our investigation revealed that the surgery times could be consistently explained by a monotonically decreasing function, indicating that a continually improving surgery performance (reduction in surgery time) was not rejectable. Our analysis was based on data pertaining to widely ranging (uncontrolled) intersurgery times (minimum intersurgery time, 0 days [ie, within the same day]; maximum intersurgery time, 142 days), and we cannot claim that this study schedule had no bearing on the results. We are currently planning future studies that will strengthen our understanding of surgical learning by further exploring the relationship between surgical skill acquisition and the amount (frequency and duration) of exposure.

We investigated reduction in surgical time as a metric to support skill acquisition; however, surgical outcomes are not simply measured on the basis of speed but also associated with efficiency, appropriate tissue handling, and surgeon performance (ie, technique). We suggest that this investigation invites future studies evaluating surgical performance and skill acquisition in veterinary surgery. The development of new surgical techniques and devices is meaningful only if they are widely accepted and applied to a large case volume. Whether new techniques are accepted depends on their efficacy and safety as well as the cost and availability of new instruments, the need for surgical retraining, and the learning curve associated with skill acquisition. Results of the present study support the notion that LESS ovariotomy is a safe and feasible technique in dogs. Also, on the basis of our results, an experienced laparoscopic surgeon can be expected to reach proficiency with LESS ovariotomy in 8 cases. Single-port surgery in veterinary laparoscopy is in its infancy, but it may become the gold standard for many procedures in veterinary laparoscopy. Further refinements in instrumentation and operative techniques are certainly required before this method of access can be widely accepted.

**References**

From this month’s AJVR

Use of contrast-enhanced ultrasonography to characterize adrenal gland tumors in dogs

Pascaline Pey et al

Objective—To describe the contrast-enhanced ultrasonographic characteristics and vascular patterns of adrenal gland tumors in dogs and determine whether those features are indicative of malignancy or histologic type of tumor.

Animals—14 dogs with 16 adrenal gland lesions (10 carcinomas [8 dogs], 3 adenomas [3 dogs], and 3 pheochromocytomas [3 dogs]).

Procedures—Unsedated dogs with adrenal gland lesions underwent B-mode ultrasonography and contrast-enhanced ultrasonography ≤ 48 hours before adrenalec-toomy. Contrast-enhanced ultrasonographic examinations were video-recorded. Macroscopic evaluation of the adrenal gland lesions and histologic examination of removed adrenal gland tissues were subsequently performed. Surgical and histopathologic findings and the ultrasonographic and contrast-enhanced ultrasonographic characteristics were recorded for the various tumor types. Time-intensity curves were generated from the contrast-enhanced ultrasonographic recordings and used to calculate regional blood volume (value proportional to area under the curve) and mean transit time (time the lesion began to enhance to the half-peak intensity).

Results—In adrenal gland carcinomas, tortuous feeding vessels were noticeable during the arterial and venous phases of contrast enhancement. Heterogeneity of contrast enhancement was evident only in malignant tumors. Compared with adenomas, adrenal gland carcinomas and pheochromocytomas had significantly less regional blood volume. Mean transit times were significantly shorter in adrenal gland carcinomas and pheochromocytomas than in adenomas.

Conclusions and Clinical Relevance—For dogs, evaluation of the vascular pattern and contrast enhancement characteristics of adrenal gland tumors by means of contrast-enhanced ultrasonography may be useful in assessment of malignancy and tumor type. (Am J Vet Res 2014;75:886–892)