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Objective: To report and compare the duration of surgery, the frequency of complications, and the frequency of open conversion for elective surgeries performed with 2 laparoscopic techniques: a single incision port access system (SPAS) and a multiple port access system (MPAS) using a Veress needle.

Study Design: Retrospective case series.

Animals: Ninety-eight consecutive, client owned dogs.

Methods: Medical records of dogs undergoing an elective laparoscopic procedure were reviewed. Dogs were classified as SPAS or MPAS according to the initial surgical approach. Duration of surgery, intraoperative complications, reason for open conversion, and postoperative complications were recorded and compared.

Results: The duration of surgery for SPAS gastropexy (P = .0039), ovarioectomy (P = .0052), and gastropexy/ovariectomy combined (P = .0002) were significantly reduced compared to corresponding MPAS procedures. Nine splenic punctures occurred during MPAS. The frequency of intraoperative complications was significantly less for SPAS (0/44) than MPAS (12/54, P = .004). Elective conversion was performed because of gastric malpositioning in 1 dog and emergent conversion was required because of bleeding from the ovarian pedicle in 2 dogs (0/44 SPAS, 3/54 MPAS, P = .250). There were 14/76 dogs with followup to suture removal with postoperative complications, all incisional (7/31 SPAS, 7/45 MPAS, P = 1.0).

Conclusion: The use of SPAS for laparoscopy reduced surgical time and intraoperative complications in elective procedures.

Laparoscopic surgery offers advantages of improved visualization of intra-abdominal organs, decreased morbidity with lower infection rates, decreased postoperative pain, and improvement in the postoperative recovery process of animals.¹⁻³ Single port access systems (SPAS) were introduced in human surgery to reduce the number of incisions while maintaining a sufficient number of cannulas to perform the surgery.⁴ The SPAS reduced surgical trauma as there was only a single incision, thereby decreasing postoperative pain, hastening recovery, and providing better cosmetic results.⁵⁻¹¹ However, SPAS has an inherent disadvantage because of loss of triangulation, which creates instrument interference. This can increase the technical difficulty and may require the use of articulated instruments.⁶ These difficulties have the potential to increase surgical time and complication rates,⁹⁻¹²⁻¹⁴ but are not prohibitive for surgeons with prior experience using multiple port access systems (MPAS).¹⁵⁻¹⁶

Multiple port access is the traditional technique used in veterinary medicine for elective and non-elective procedures.¹⁻³⁻¹⁷⁻⁻²⁴ A single port technique with a working telescope for ovarioectomy was developed to reduce the number of ports required.²² This technique does not allow triangulation and has been shown to increase surgical time over a 2-port technique.²³ Single port access systems are used during veterinary laparoscopic procedures.²⁵⁻²⁷ There are no reports in the veterinary literature comparing the duration of surgery, the frequency of complications, and the frequency of open conversion for procedures performed with SPAS and MPAS.

The objective of this case series was to compare surgery duration, the frequency of complications, and the frequency of open conversion between SPAS and conventional MPAS in selected, sequential, elective laparoscopic procedures. This study was designed to test the hypothesis that these outcomes would be different between SPAS and MPAS.

MATERIALS AND METHODS

Medical records of dogs that had an elective laparoscopic procedure (prophylactic gastropexy, ovarioectomy, ovariohysterectomy, and cryptorchidectomy) between 2005 and 2014 were reviewed. Cases were excluded if medical records were incomplete or if another procedure was performed under the
same anesthesia. Procedure types were excluded if there were less than 20 cases available. Cases were classified as SPAS if the procedures were performed with a single port access (SILS, Covidien, Mansfield, MA) or MPAS if the procedures were performed with multiple port access technique. The MPAS was defined as the use of a combination of at least 2 cannulas placed at different incision sites in the abdominal wall.

Information retrieved from medical records included signalment (age, breed, sex, body weight), surgical data, and postoperative complications until follow-up at suture removal. Other data retrieved included date of surgery, procedure performed, total duration of surgery from skin incision to skin closure, use of SPAS or MPAS, use of a Veress needle, number of cannulas used in each surgery, intraoperative complications, and reason for open conversion.

A complication was defined as an intraoperative event that required additional management to correct or increase the probability of a poor outcome. Intraoperative complications were classified as major if they required a celiotomy for corrections (i.e., open conversion), otherwise they were classified as minor. Conversion was differentiated as elective (decision not based on the occurrence of a complication) and emergent (surgeon decision based on a complication which was not manageable using laparoscopy). Postoperative complications were those related to surgery that occurred after surgery until suture removal. Postoperative complications were classified as major if they required surgical intervention and minor if not. Incisional complications were described as seroma, infection, and dehiscence.

Continuous data are reported as mean and standard deviation (SD) and compared between SPAS and MPAS with a Student's t-test. The frequency of intraoperative and postoperative complications, and conversion (elective versus emergent) were compared across SPAS and MPAS with a Fisher's exact test. Significance was set at a $P < .05$ (JMP™ 11, SAS Institute, Cary, NC).

RESULTS

One hundred and thirteen dogs underwent elective laparoscopic procedure between 2005 and 2014, of which 98 were included in the study. Fifteen dogs were excluded for insufficient strata density (ovariohysterectomy, cryptorchidectomy). There were 44 SPAS procedures, all performed between 2010 and 2014, and 54 MPAS, all performed before 2010 (Fig 1). The exception was 1 dog weighing 2 kg that had an ovarioectomy with two 2.7-mm cannulas in 2013. Procedures included 46 gastropexy (16 SPAS, 30 MPAS), 27 ovarioctomy (15 SPAS, 12 MPAS), and 25 combined gastropexy/ovarioctomy (13 SPAS, 12 MPAS). The SPAS was always placed with a mini-laparotomy approach. A Veress needle was used in all MPAS procedures. Straight instruments and a 0° 5-mm telescope (Hopkins II; Storz™, Goleta, CA) were used for all procedures. All surgeries were performed by a faculty or a resident under faculty supervision.

Figure 1 Timeline and number of procedures performed by multior access system (MPAS) and single port access system (SPAS).

There was no significant difference in the sex distribution ($P = .275$) with 33 females (5 spayed) and 11 males (4 castrated) undergoing SPAS and 34 females (8 spayed) and 20 males (16 castrated) undergoing MPAS. Dogs undergoing SPAS were significantly younger (mean [SD] 26.1 [30.8] months) compared to dogs undergoing MPAS (44.4 [36.2] months, $P = .009$). There was no significant difference in body weight for dogs undergoing SPAS (31.9 [13.8] kg) compared to MPAS (37.5 [17.9] kg, $P = .089$). There was no significant difference in maximum intra-abdominal insufflation pressure for dogs undergoing SPAS (12.3 [1.0] mmHg) compared to MPAS (12.7 [1.0] mmHg, $P = .128$).

Gastropexies for all SPAS and MPAS were performed laparoscopic-assisted as described by Rawlings et al.17 For SPAS, the SILS port was placed at the site of the incisional gastropexy. Ovariectomy by SPAS was performed with straight instruments and no percutaneous hook was used. A fine-toothed forceps was used to elevate the ovary in the peritoneal space. The SPAS was placed caudal to the umbilicus. Ovariectomies by MPAS used 2 cannulas (1 x 5-mm and 1 x 10-mm cannula) and a percutaneous hook (Karl Storz, Karl Storz Veterinary Endoscopy, Goleta, CA) to stabilize the ovary against the abdominal wall.18 In 9 dogs for MPAS, the combined gastropexy/ovariectomy was performed as described by Rivier et al.19 In 3 dogs, 2 cannulas were used instead of 3, with 1 cannula placed caudal to the umbilicus on midline and the other placed behind the last rib on the right side where the laparoscopic-assisted gastropexy was planned. During ovariectomy, a percutaneous hook was used to stabilize the ovaries against the abdominal wall. Combined gastropexy/ovariectomy with SPAS had the SILS port placed at the site of the gastropexy and ovariectomy performed first, without any percutaneous hook. After removal of both ovaries, the pyloric antrum was grasped with a fine-toothed forceps, the SILS port was removed, and the incisional gastropexy was completed as described by Rawlings et al.17 A 10-mm bipolar, vessels-sealing device (Atlas Ligasure™, Force Triad, Covidien,
Mansfield, MA) was used for hemostasis of the ovarian pedicle in all procedures.

The surgery duration for gas troscopy for SPAS was significantly shorter (43 [14] minutes) than MPAS (61 [22] minutes, \( P = .0039 \)). The surgery duration for ovariec tomy for SPAS was significantly shorter (43 [13] minutes) than MPAS (70 [31] minutes, \( P = .0052 \)). The surgery duration for combined gas troscopy/ovariectomy for SPAS was significantly shorter (66 [29] minutes) than MPAS (132 [44] minutes, \( P = .0002 \)). For MPAS, a median of 2 cannulas (range 2–3 cannulas) were used per dog. Two cannulas were used for all gas troscopy, and a median of 2 cannulas (range 2–3) for ovariec tomy, and combined gas troscopy/ovariectomy procedures.

Twelve of 98 dogs (12%) had intraoperative complications of which 9/98 (9%) were minor and 3 were major. The frequency of intraoperative complications was significantly different between SPAS (0/44) and MPAS (12/54, \( P = .0004 \)). All 9 minor complications were hemorrhage due to spleenic puncture, mostly likely by the Veress needle, and this occurred in 5 gas troscopy, 1 ovariec tomy, and 3 combined gas troscopy/ovariectomy (9/54, 17%).

Open version (major intraoperative complication) was required for 3 dogs (3/98, 3%), all undergoing MPAS. The frequency of open conversion was not significantly different between SPAS (0/44) and MPAS (3/54, \( P = .250 \)). Elective conversion was performed due to gastric malpositioning in 1 dog (in 2007). Emergent conversion due to bleeding from the ovarian pedicle, uncontrolled by application of the vessel-sealing device, was required in 2 dogs (in 2006 and 2011).

Follow-up until suture removal was available for 76 dogs. Postoperative complications were recorded in 14 dogs, all minor and related to infection of the incision site (14/76, 18%). All minor complications resolved with topical treatment or oral antibiotics. The frequency of postoperative complications was not significantly different between SPAS (7/31) and MPAS (7/45, \( P = .590 \)) overall or when stratified on procedure (gastroscopy SPAS 4/13, MPAS 4/25, \( P = .406 \); ovariec tomy SPAS 0/9, MPAS 1/11, \( P = 1.0 \); combined gas troscopy/ovariectomy SPAS 3/9, MPAS 2/9, \( P = 1.0 \)). Within SPAS or MPAS, the frequency of complications was not different across surgical procedures (SPAS \( P = .064 \); MPAS \( P = .711 \)). The frequency of incisional complication was not significantly different between laparoscopic-assisted procedures (13/59) and laparoscopic procedures (1/17, \( P = .095 \)).

**DISCUSSION**

This study found the frequency of intraoperative complications with SPAS was significantly less than with MPAS for elective laparoscopic procedures. Postoperative complications were not different, nor were the frequency of emergent/elective conversions. As expected, the surgery duration was shorter when SPAS was used.

The case series examined in this study is similar to others described for ovariec tomy, gas troscopy, or combination procedures.\(^{1,17–19,22,23,25,29,30}\) The dogs undergoing SPAS and MPAS were not different in weight or sex distribution but those undergoing SPAS were younger, likely because more ovariec tomy procedures alone were performed this way than combined with gas troscopy.

Minor intraoperative complications occurred in 9% of dogs, related to the approach in all cases, specifically spleenic puncture by the Veress needle. None of the dogs required open conversion. Spleenic puncture is the most frequent complication reported in the veterinary literature with laparoscopic elective surgery (0–18%) but is not reported as a cause for open conversion.\(^{1,17–19,22,23,25,29,30}\) Spleenic punctures did not occur in any dog with SPAS. The single port access was bluntly inserted using Carmalt forceps after performing a 2 cm incision in the linea alba. The edges of the incision were elevated with Allis tissue forceps or sutures. This Hasson open approach can also be used to eliminate the use of a Veress needle with MPAS.\(^{31}\)

The rate of conversion to open surgery was 3% in this study with 2 emergent conversions because of bleeding of the ovarian pedicle that could not be controlled with the vessel-sealing device. Conversion to an open surgery has not been reported for elective procedures like ovariec tomy or gas troscopy.\(^{1,17–19,22,23,25,29,30}\) Pope et al.\(^{30}\) report puncture of the urinary bladder in 3 cases that were repaired through a cannula site without opening the abdominal cavity. In 1 dog in the current report, the abdomen was opened to reposition the stomach based on surgeon decision. This was considered elective. Conversions were only with the MPAS. As this case series was sequential, the surgeons were likely more experienced when SPAS was used. Recent studies with SPAS did not report any conversion for gas troscopy or ovariec tomy.\(^{26–27}\)

Runge et al.\(^{28}\) stated that the combination of articulating instruments and a 30° angled telescope provides increased triangulation and improved working space with SPAS. However, the utilization of curved or articulated instruments requires the surgeon to cross-hand during the procedure, which is more difficult to learn and master.\(^{33}\) Runge et al.\(^{33}\) reported that 8 cases were required to become proficient with curved instruments and an angled-telescope for a surgeon experienced with minimally invasive surgery. In this study, straight instruments and a 0° telescope were used for all SPAS. Meticulous planning before using SPAS is required to minimize interference.\(^{25}\) Standard instruments instead of articulated instruments have been used successfully for adrenalectomy or cholecystectomy in people with SPAS.\(^{34}\)

Single port access resulted in a shorter duration of surgery for all 3 procedures. Laparoscopic ovariec tomy or laparoscopic ovariohysterectomy with MPAS is reported to take from 19 to 120 minutes, a large variation, which captures the duration reported in this study for MPAS.\(^{1,18,19,22,23}\) Runge et al.\(^{29}\) reported a median surgery duration of 65 minutes for laparoscopic gas troscopy and ovariec tomy via SPAS, also similar to the surgery duration reported here for gas troscopy and ovariec tomy performed by SPAS. Another report of SPAS ovariec tomy taking 52 minutes\(^{25}\) is longer than the duration reported in the current study, perhaps because that technique
placed 3 separate ports through 1 single skin incision, which is
time-consuming. Decreased surgery duration with SPAS may
be, in part, because of obviatiou of the use of a Veress needle,
obviatiou of the hook for ovariectomy, and the fact that the
approach for gastroplasty is made before the port is in place.

The overall postoperative complication frequency was
18% with all complications related to the surgical incision. A
retrospective study on 618 dogs undergoing laparoscopic
ovariectomy reported incisional complications in 14% of dogs,
and dehiscence and herniation in 0.6%. River et al.29
reported seroma formation in 15% of dogs undergoing
combined laparoscopic gastroplasty/ovariectomy. In the
present study, the port system was not associated with
complications, nor was the procedure (laparoscopic-assisted
or laparoscopic). The length of the skin incisions for SPAS
and MPAS was not recorded in this study.

This study has limitations as multiple surgeons with
different levels of experience and skill were involved. All
surgeries were performed by a faculty or a resident under
faculty supervision but experience influences the surgery
duration and likelihood of complication and conversion.28
There was no randomization across procedures and as
surgeries were sequentially performed, systematic bias can
be introduced with procedure type. The MPAS procedures
were almost all performed before the SPAS procedures. Any
laparoscopic procedure before 2005 was not entered because
they were all MPAS and considered part of our learning curve.
Entering those cases would have created a further bias against
MPAS. In addition, a vessel-sealing device was not always
available for ovariectomy before 2005. When SPAS was
introduced in 2010, it was used more often than MPAS to
finally being exclusively used. The surgeons were thus
experienced with MPAS before using SPAS. One could argue
this is a natural progression of skill in laparoscopic surgery
and thus any SPAS assessment is always biased by prior skill.

In conclusion, the use of SPAS is applicable for elective
laparoscopic procedures and is associated with minimal
complications. Assuming a learning curve for SPAS, once
skilled, the use of SPAS shortens surgery duration over MPAS
without increasing the frequency of complications.

DISCLOSURE

The authors declare no conflicts of interest related to this
report.

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