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Objective—To describe the technique and evaluate the outcome of laparoscopic treatment of ovarian remnant syndrome (ORS) in dogs and cats.

Design—Retrospective case series.

Animals—7 client-owned dogs and cats.

Procedures—Medical records of dogs and cats with ORS that were treated laparoscopically at 3 large veterinary teaching hospitals were reviewed. Laparoscopic ovarian remnant resection was performed by means of either a 3-port or single-port technique with the patient in dorsal recumbency. The area caudal to both kidneys was thoroughly inspected for evidence of ovarian tissue by tilting the patient laterally. Any ovarian remnant tissue in these areas was resected with a bipolar vessel sealer.

Results—5 female dogs and 2 female cats that had previously undergone ovariectomy or ovariohysterectomy were included in the study. Six procedures were performed with a standard 3-port technique, and 1 was performed with a single-port technique. Median surgery time was 90 minutes (range, 50 to 150 minutes). No patient required conversion to laparotomy. Six of the 7 patients had complete resolution of clinical signs after surgery. One patient underwent laparotomy 7 weeks after surgery for management of stump pyometra, but no further ovarian tissue was detected.

Conclusions and Clinical Relevance—Laparoscopic management of ORS in this cohort of dogs and cats was associated with minimal morbidity. Laparoscopic treatment of ORS in dogs and cats may be recommended for appropriately selected patients. (J Am Vet Med Assoc 2014;245:1251–1257)
terone, and luteinizing hormone concentrations can be used to confirm ORS, although hormone stimulation testing has been shown to be more reliable for obtaining a preoperative diagnosis. Ultrasonographic findings of cystic structures or hypoechoic masses in the region of the ovarian pedicle are useful in confirming the presence of an ovarian remnant. Exploratory surgery should be attempted when the patient is in proestrus, estrus, or diestrus, when the follicles or corpora lutea are enlarged along with the ovarian vasculature, enhancing identification of the ovarian remnant. Complete surgical removal of all remnant ovarian tissue results in resolution of clinical signs associated with estrus and proestrus.

Surgical exploration and removal of ovarian tissue has traditionally been accomplished via a ventral celiotomy approach. Laparoscopic ovariectomy has been described in dogs in multiple studies and has been associated with a faster return to activity after surgery, compared with an open ovariectomy technique. A recent study compared laparotomy and laparoscopy for management of ORS in human patients and found that patients treated with laparoscopy experienced less blood loss, shorter hospital stays, and similar operating times, compared with those undergoing laparotomy. However, there are no reports of laparoscopic management of ORS in veterinary patients.

The aims of the study reported here were to describe a technique for laparoscopic management of ORS in dogs and cats and to report the short- and long-term outcome for patients treated with this technique.

Materials and Methods

Case selection—Medical records from 3 large veterinary teaching hospitals were reviewed to identify dogs and cats that had clinical signs, laboratory findings, and results of diagnostic imaging consistent with hormone-secreting residual ovarian tissue and had undergone laparoscopic management of ORS. Records for patients undergoing surgery between 2010 and 2013 were included. Signalment, medical history, clinical signs, physical examination findings, time since initial ovariectomy or ovariohysterectomy, abdominal ultrasonography findings, anesthetic protocol, surgical procedure, histopathologic findings, and client follow-up data were recorded. Follow-up data regarding persistence or reoccurrence of clinical signs consistent with ORS were obtained at a median duration of 12 months after laparoscopic corrective surgery (range, 5 to 40 months). Minimum follow-up time was not an exclusion criterion in this study. Prior laparoscopic ovariohysterectomy was not an exclusion criterion in this study.

Anesthesia protocol—Anesthetic protocol was selected at the discretion of the anesthesiologist assigned to the case. Dogs were premedicated with atropine (0.02 to 0.04 mg/kg [0.009 to 0.018 mg/lb], SC or IM) and hydromorphone hydrochloride (0.05 to 0.1 mg/kg [0.023 to 0.045 mg/lb], SC or IM) or oxymorphone hydrochloride (0.05 to 0.1 mg/kg, SC or IM). Anesthetic induction was performed by administration of propofol (up to 10 mg/kg [4.5 mg/lb], IV). Cats were premedi-
The subcutaneous tissues were closed in a simple interrupted pattern with 3-0 polyglecaprone, and the skin incisions were closed with 3-0 to 4-0 nylon in an interrupted cruciate suture pattern.

**Results**

**Animals**—Five female dogs and 2 female cats that had previously undergone laparoscopic ovarioectomy or ovariohysterectomy via a traditional open surgical approach were included in the study. Dogs included 2 Labrador Retrievers, 2 mixed-breed dogs, and 1 Bullmastiff. Both cats were domestic shorthairs. The median weight of the dogs was 29.2 kg (64.2 lb; range, 27 to 44.5 kg [59.4 to 97.9 lb]), and the median age was 48 months (range, 11 to 108 months). The cats weighed 3.2 and 3.9 kg (7.0 and 8.6 lb) and were 12 and 44 months old.

**Clinicopathologic data**—Median age at the time of initial ovarioectomy or ovariohysterectomy was 6 months (range, 2.5 to 43 months). Six patients had a prior ovariohysterectomy, and 1 had a prior ovarioectomy. All ovariohysterectomy procedures had been performed via a celiotomy approach, whereas the ovarioectomy procedure had been performed laparoscopically. The median interval between the initial ovarioectomy or ovariohysterectomy and surgical treatment of ORS was 36 months (range, 1 to 102 months). The median interval between onset of clinical signs and laparoscopic corrective surgery for 6 of the patients (data unavailable for 1 dog) was 10.5 weeks (range, 3 to 24 weeks). One cat had clinical signs consistent with a state of estrus 4 weeks prior. Eight weeks after the onset of clinical signs, the referring veterinarian performed an exploratory laparotomy, which revealed suspected ovarian tissue in the region of the right ovarian pedicle and abdominal wall adhesions to the jejunum. Results of histopathologic analysis of the excised suspected right ovarian tissue were not available. The cat continued to show signs of estrus every 3 weeks until the laparoscopic procedure to address ongoing signs of ORS.

Clinical signs described by owners after the original ovarioectomy or ovariohysterectomy procedure included hemorrhagic vulvar discharge (5 dogs), vulvar swelling (5 dogs), mammary gland enlargement (3 dogs and 2 cats), and behavioral changes (1 dog and 2 cats). Four of the patients had vaginal cytologic evaluation performed as part of their initial workup. All 4 had evidence of intermediate or superficial cells on serial vaginal cytologic evaluation, consistent with a state of proestrus or estrus. Two of these patients had additional hormonal assays. One had a luteinizing hormone concentration < 1 ng/mL (a luteinizing hormone concentration < 1 ng/mL is consistent with a spayed bitch or queen), suggestive of circulating estrogens suppressing pituitary luteinizing hormone secretion. Once serial vaginal cytologic evaluation detected < 50% anuclear cells, 25 µg of gonadotropin-releasing hormone was administered. Seven days later, a high progesterone concentration (15.5 nmol/L [4.92 ng/mL]) was detected, consistent with a functional corpus luteum. The other animal had an estradiol concentration of 20.7 pg/mL (a concentration > 15 pg/mL is consistent with active ovarian follicles). Vaginal cytologic evaluation was performed periodically until intermediate and cornified epithelial cells were detected.

All 7 patients had ultrasonographic findings of a hypoechoic mass in the region of the ovarian pedicle consistent with an ovarian remnant. Three patients had ultrasonographic findings consistent with a right-sided ovarian remnant, and 4 patients had findings consistent with a left-sided ovarian remnant. No patients had ultrasonographic findings consistent with bilateral ovarian remnants; however, one cat had undergone a previous exploratory laparotomy to remove sus-
pected right-sided ovarian tissue and had subsequent ultrasonographic findings consistent with a left-sided ovarian remnant. Additional ultrasonographic findings included an enlarged uterine stump (6 patients), remnant uterine horn (2 patients), and cystic ovarian follicles (2 patients). No additional diagnostic testing was performed to evaluate the extraovarian pathological changes prior to laparoscopic surgery.

Operative data—Median anesthetic time was 150 minutes (range, 90 to 175 minutes). Median surgery time was 90 minutes (range, 50 to 150 minutes). Six of the procedures were performed with a standard 3-port technique, and 1 was performed with a single-port technique† (surgical time, 80 minutes). The longest surgical times (150 and 110 minutes) were associated with the 2 patients with granulosa-theca cell tumors. The suspected ovarian remnant was located in the region of the right ovarian pedicle in 3 patients, and the remnant was located in the region of the left ovarian pedicle in 4 patients, matching the preoperative ultrasonographic findings. In 1 case of a right ovarian remnant after a laparoscopic ovariohysterectomy, attempts at transection and ligation of the right uterine horn with the 5-mm bipolar vessel-sealing device were unsuccessful because of the large amount of uterine tissue and small jaws of the instrument. This was mitigated by placement of an endoscopic loop ligature® around the proximal end of the right uterine horn prior to transection of the tissue with laparoscopic scissors. No clinically important hemorrhage was noted in any case, although no accurate quantification of blood loss was performed in these cases. No patients required conversion to laparotomy. All the laparoscopic procedures were performed either primarily or by the direct guidance of a board-certified surgeon with substantial experience in laparoscopic surgery.

Postoperative care—Postoperative analgesic regimens were prescribed at the discretion of the attending clinician. All dogs received hydromorphone (0.05 mg/kg [0.023 mg/lb], SC or IV), methadone (0.2 mg/kg [0.091 mg/lb], IV), or buprenorphine (0.01 mg/kg [0.0045 mg/lb], SC or IV) at 4- to 6-hour intervals for approximately 12 to 24 hours. Three patients were discharged the same day as the procedure, and 4 patients were discharged from the hospital the morning after. Two dogs were prescribed carprofen (2.2 mg/kg [1.0 mg/lb], q 12 h for 3 to 7 days), 2 dogs were prescribed tramadol (2 to 5 mg/kg [0.9 to 2.3 mg/lb], q 8 to 12 h for 3 to 7 days), and 1 dog was prescribed both carprofen (2.2 mg/kg, q 12 h for 3 to 7 days) and tramadol (2 to 5 mg/kg, q 8 to 12 h for 3 to 7 days). Cats received buprenorphine (0.01 mg/kg [0.0045 mg/lb], sublingually, q 8 h for 3 days) and meloxicam (0.01 mg/kg [0.0045 mg/lb], PO, q 24 h for 3 days). Incisions were closed with absorbable suture material, and follow-up communications were conducted via telephone, except in the case of persistent clinical signs.

Histopathologic findings—Histologic evaluation revealed that 2 dogs had granulosa-theca cell tumors (1 with metastasis to the adjacent adipose tissue) and 4 had remnants of ovarian tissue. One dog with a granulosa-theca cell tumor had documented complete excision of the tumor with tumor-free margins, whereas in the other case, the pathologist’s report did not comment on the tumor margins specifically. In one dog, the uterine horn was removed in conjunction with the remnant ovarian tissue. No histopathologic abnormalities were noted in the associated uterine horn. The uterine stumps were removed in 2 dogs, both of which had evidence of cystic endometrial hyperplasia. One dog had evidence of cystic endometrial hyperplasia, but tissue from the region of the suspected ovarian remnant could not be confirmed to be ovarian tissue.

Outcome—All patients were discharged from the hospital within 48 hours after surgery, depending on surgeon preference. Median follow-up time by either recheck examination or telephone call was 12 months (range, 5 to 40 months). Both cats and 4 of the 5 dogs had no complications, and clinical signs associated with ORS had resolved completely. Owners of the dog that did not have any histologic evidence of ovarian tissue in the tissue that was removed from the suspected site of an ovarian remnant reported complete resolution of clinical signs in the 19.5-month follow-up period.

One of the dogs with a granulosa-theca cell tumor removed at the time of surgery developed purulent vaginal discharge and had stump pyometra diagnosed 2 weeks following surgery after a fluid-filled uterine stump was visualized on abdominal ultrasonography. Ultrasonography at the time of the original laparoscopic ORS procedure had revealed uterine stump hypertrophy without evidence of free fluid within the uterine stump lumen. Vaginal cytologic evaluation at the 2-week postoperative recheck examination showed high numbers of degenerate neutrophils, intracellular and extracellular cocci, parabasal cells, and superficial intermediate cells (approx 50:50) with occasional ciliated epithelial cells. A laparotomy was performed in this patient (surgical time, 95 minutes) 7 weeks after laparoscopic surgery. A follicular structure in the region of the left ovarian pedicle, a nodular structure in the region of the right ovarian pedicle, and an omental mass in the region of the uterine stump were submitted for histologic evaluation; findings were consistent with chronic granulation tissue with steatitis. Histologic evaluation of the proximal aspect of the uterine stump revealed evidence of moderate diffuse endometrial hyperplasia. No evidence of neoplastic or ovarian tissue was noted during examination of H&E-stained sections, and cells had negative results on immunohistochemical staining with inhibin. The patient had complete resolution of clinical signs after the laparotomy.

Discussion

In the present study of 5 dogs and 2 cats undergoing laparoscopic treatment of ORS over a 3-year period (2010 through 2013) at 3 veterinary teaching hospitals, surgery was successfully completed in all patients. None of the patients required conversion to an open laparotomy. Six of the 7 patients had complete resolution of clinical signs after surgery, and 1 required a laparotomy 7 weeks after surgery for management of stump pyometra, but no additional ovarian tissue was discovered. As such, we suggest that laparoscopic removal of remnant ovarian tissue is a viable minimally invasive
alternative to open laparotomy for the treatment of ORS in dogs and cats. 

Previous studies have shown that laparoscopic ovariohysterectomy in healthy dogs results in decreased postoperative pain and surgical stress for patients, compared with standard open ovariohysterectomy, and may lead to lower postoperative surgical site infection rates. Although these benefits were demonstrated in healthy dogs undergoing elective surgery, the advantages of a laparoscopic surgical technique are likely applicable to any dog or cat undergoing laparoscopic ovariohysterectomy or ovarioectomy. The laparoscopic technique may be particularly relevant to ovarian remnant removal, where close examination and visualization of the ovarian pedicles are required and where an open celiotomy approach would most likely require a larger celiotomy incision than for elective ovariohysterectomy or ovarioectomy. The minimally invasive approach may also lead to less tissue trauma and thus less local inflammatory mediator release and reduced compromise of the systemic immune defenses, compared with an open technique. One potential disadvantage of a laparoscopic approach may lie in the fact that tactile sensation for evaluation of tissues in the area of the previously resected ovarian pedicle may be diminished. In cases where major adhesions exist or if the remnant ovarian tissue is not obviously visible, digital palpation of the area may be beneficial, in which case conversion to an open approach may be advised. However, this was not found to be necessary in any cases in this study. One dog in this study developed ORS after it was initially spayed by means of laparoscopic ovarioectomy. This is a previously unreported complication of laparoscopic ovarioectomy in dogs and demonstrates that ORS can occur after either open or laparoscopic surgery. Future studies should address whether the risk of ORS is any different between open and laparoscopic ovarioectomy or ovariohysterectomy procedures.

To our knowledge, there are no other reports of laparoscopic management of ORS in small animal patients. A comparison of minimally invasive surgery and laparotomy for the management of ORS in humans found that patients that underwent laparoscopic surgery for ovariohysterectomy had less blood loss, shorter hospital stays, and similar operating times, compared with values for patients that underwent laparotomy. Blood loss was not quantified in the patients in the present report, but was subjectively minimal in all cases, with no clinically important hemorrhage reported in any case. All patients were discharged from the hospital the same day or the morning after their procedure. Both the 3-port laparoscopic technique and the single-port technique allowed for excellent visualization and triangulation of both ovarian pedicles. Both approaches used midline incisions, minimizing soft tissue dissection and the risk of postoperative seroma formation, compared with the use of paramedian portals.

Surgical time was quite variable, with a median duration of 90 minutes (range, 50 to 150 minutes). Surgical time was likely influenced by many factors, including pathological changes within the abdomen, patient and lesion size, and surgeon experience. The 2 cases associated with the longest surgical times were those with granulosa-theca cell tumors (150 and 110 minutes). The 2 patients with granulosa-theca cell tumors also had the longest intervals (54 and 102 months) between initial ovarioectomy or ovariohysterectomy and clinical evaluation for ORS. This limited data set supports the association noted by Ball et al, who found that patients with neoplastic ovarian tissue had a significantly longer median interval of 96 months (range, 47 to 120 months) to evaluation for ORS, compared with patients without neoplastic tissue (median, 12 months; range, 1 to 60 months).

No serious intraoperative complications occurred in any cases in this study. The single long-term complication occurred in a dog with a granulosa-theca cell tumor and evidence of local metastasis on histologic evaluation. This patient developed a purulent vulvar discharge 10 days after surgery. At the 2-week postoperative recheck examination, it had an enlarged vulva with a large amount of thick, purulent discharge with intracellular and extracellular cocci. This patient ultimately required an exploratory laparotomy 7 weeks after surgery, during which tissue from the uterine stump and both ovarian pedicles was removed. No neoplastic or ovarian tissue was observed on histologic evaluation. We suggest that this patient developed pyometra prior to or shortly after the initial corrective laparoscopic ovarioectomy procedure, secondary to previously established cystic endometrial hyperplasia, but clinical signs were not apparent until the 2-week recheck evaluation. At that time, ultrasonographic examination revealed fluid within the uterine stump lumen, whereas at the time of the laparoscopic ORS procedure, the stump had been described as hypertrophic but not fluid filled. During the initial laparoscopic procedure, the uterine stump was observed to be slightly distended and turgid caudal and lateral to the bladder, but there was no history of purulent discharge or evidence of it on physical examination. It is also possible that ovarian tissue remained undetected in this patient, although we believe this explanation to be less likely given the fact that clinical signs resolved after the second procedure and follow-up information via telephone for this dog was available 40 months after the ORS was treated.

Histologic evaluation did not yield evidence of ovarian tissue for 1 dog, but examination of the associated uterine tissue showed cystic endometrial hyperplasia. The patient had prior vaginal cytologic examination findings consistent with a state of estrus. Abdominal ultrasonography showed an enlarged thickened uterus and a potential left ovarian remnant. The patient also had a history of chronic diethylstilbestrol administration for suspected urethral sphincter mechanism incontinence. Although it is possible that the patient had an ovarian remnant, given the clinical signs and results of cytologic evaluation and diagnostic imaging, one cannot rule out the possibility of a pseudo-ovarian remnant secondary to the iatrogenic administration of synthetic estrogens. Synthetic exogenous estrogens such as diethylstilbestrol, estriol, and ethinyl estradiol and esters of estradiol such as benzoate, cypionate, propionate, valerate, enanthate, and undecylenate can exert the same effects as natural estrogens. Diethylstilbestrol administration was discontinued at the time of...
the laparoscopic procedure. The patient had complete resolution of clinical signs of both urinary incontinence and suspected ORS at the 19.5-month follow-up examination. Owing to the lack of histologic confirmation of ovarian tissue and the fact that clinical signs abated after laparoscopic surgery and concurrent discontinuation of diethylstilbestrol administration, it was impossible to determine whether the patient had clinical resolution of ORS or of a pseudo-ovarian remnant state.

Careful case selection for laparoscopic ovariectomy for treatment of ORS is crucial to ensure a favorable surgical outcome and minimize the risk for the need to convert to an open approach. Patient size was not a limiting factor in this study, and we were able to perform the procedure in patients ranging from 3.2 to 44.5 kg. Patients should be screened for exogenous estrogen sources that can mimic the clinical signs of ORS. The use of exogenous estrogens such as diethylstilbestrol may explain the presence of behavioral changes and physical examination findings consistent with remnant ovarian tissue but lack of histologic evidence of ovarian tissue in 1 dog. Case selection should be based on a combination of behavioral changes, clinical signs, results of vaginal cytologic evaluation and hormonal assays, and abdominal ultrasonographic findings consistent with an ovarian remnant. Ultrasonographic findings correctly predicted the location of the ovarian tissue in 6 of the 7 patients in the present study, but presurgical diagnostic tests were unable to differentiate ovarian neoplasia from benign remnant tissue. One cat had a left-sided ovarian remnant that was seen ultrasonographically and removed laparoscopically, despite having a previous exploratory laparotomy for removal of a right-sided ovarian remnant.

Potential disadvantages of the laparoscopic ovariec- tomy procedure for the treatment of ORS include equipment expense, need for specialized training, and need for additional assistants. Initial surgical times may be longer with laparoscopic ovariectomy, compared with laparotomy, if the surgeon is unfamiliar with the technique. Surgical times are likely to improve as experience with this technique is gained. A randomized study comparing open and laparoscopic approaches for the treatment of both benign and malignant ovarian remnant tissue would be needed to test this hypothesis but is challenging because of the infrequent occurrence of ORS. An additional limitation of the laparoscopic technique is the inability to perform a complete examination of the abdominal viscera with digital palpation of the organs. Laparoscopy allows for a highly detailed but focal field of view. Abdominal organs must be manipulated with laparoscopic instruments or repositioned by rotating the patient to achieve an adequate field of view. Although ultrasonography proved to be a reliable tool to identify ovarian remnants and aid in surgical planning, CT may be used as a complimentary imaging modality when the certainty or inaccessibility of a lesion is questionable.

Results of the present study indicated that laparoscopic ovariectomy can successfully be performed by both a 3-port and a single-port technique for the surgical management of ORS due to both benign and malignant ovarian tissue. Perioperative complications were limited to the need for an endoscopic loop ligature to facilitate ligation of a large-diameter uterine horn. All 7 patients in this study survived to discharge from the hospital, and 6 had complete resolution of their clinical signs with a single operation. To minimize the risk of complications and increase the likelihood of a favorable outcome, appropriate case selection and availability of trained personnel and equipment are vital. Further studies examining laparoscopic ovariectomy for the treatment of ORS with a larger sample size and larger range of patient sizes are needed to better assess the potential benefits of this procedure, compared with open laparotomy.

References

Comparison of peribulbar and retrobulbar regional anesthesia with bupivacaine in cats

Yael Shilo-Benjamini et al

Objectives—To compare effectiveness and complications associated with peribulbar and retrobulbar anesthesia with bupivacaine in cats.

Animals—6 healthy adult cats.

Procedures—Cats were sedated with dexmedetomidine and received a peribulbar injection of 0.5% bupivacaine (1.5 mL), iopamidol (0.5 mL), and saline (0.9% NaCl) solution (1 mL) or retrobulbar injection of 0.5% bupivacaine (0.75 mL) and iopamidol (0.25 mL) in a crossover study with ≥ 2 weeks between treatments. The contralateral eye was the control. Injectate distribution was evaluated with CT. After atipamezole administration, periocular and corneal sensations, intraocular pressure (IOP), and ocular reflexes and appearance were evaluated for 24 hours.

Results—All peribulbar and 3 of 6 retrobulbar injections resulted in CT evidence of intracanal injection. Corneal sensation and periocular skin sensation were absent or significantly reduced relative to that for control eyes for 3 hours after peribulbar injection. Mean ± SD IOP immediately after injection was significantly higher for peribulbar injections (33 ± 12 mm Hg) than for control eyes or retrobulbar injections (both 14 ± 4 mm Hg) but 10 minutes later decreased to 18 ± 3 mm Hg. Exophthalmos, chemosis, and ptosis were evident in most injected eyes, and irritation was evident in 3 of 6 peribulbar-injected and 1 of 6 retrobulbar-injected eyes. All conditions resolved within 14 hours.

Conclusions and Clinical Relevance—Peribulbar injection resulted in intracanal deposition of bupivacaine in a higher percentage of cats than did retrobulbar injection and induced notable anesthesia relative to that for the control eye; however, IOP increased temporarily. (Am J Vet Res 2014;75:1029–1039)