Assessment of Postoperative Pain in Cats After Ovariectomy by Laparoscopy, Median Celiotomy, or Flank Laparotomy

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Objective: To compare postoperative pain, duration of surgery, and duration of anesthesia for 3 methods of ovariectomy in cats: (1) conventional ventral median open approach (Midline), (2) right flank approach (Flank), and (3) median 2-portal laparoscopic procedure (Lap).
Study Design: Randomized, prospective clinical trial.
Animals: Healthy, sexually intact female cats (n = 60).
Methods: Cats were randomly assigned to 1 of 3 groups: Midline (n = 20), Flank (20), and Lap (20) were evaluated 1, 2, 4, 6, and 12 hours after endotracheal extubation. Postoperative pain was scored using the 4A-vet pain scale that combines a subjective numerical pain rating and objective scoring of physiologic and behavioral variables including the response to stimulation of the surgical site. Pain scores (PS) were compared between groups.
Results: There was a significant difference in the PS between groups. PS for Midline and Flank were not significantly different but were both significantly higher compared with Lap. Depending on time, 5–20% of the cats had intense postoperative pain in both Midline and Flank groups. None of the Lap cats had intense postoperative pain.
Conclusions: Laparoscopic ovariectomy, although slower, appeared less painful compared with conventional ventral midline and flank ovariectomy. Postoperative pain did not differ significantly between midline and flank groups.

Ovariectomy is recommended by some surgeons instead of ovariohysterectomy for elective sterilization of female dogs.[1–3] Particularly in European countries, ovariectomy is one of the most common surgical procedures for neutering cats and is widely used for teaching during surgical laboratories. Elective ovariectomy and ovariohysterectomy can be achieved through both ventral median celiotomy and unilateral or bilateral flank laparotomy.[4–7] Laparoscopic (Lap) or laparoscopic-assisted procedures have become more common for reproductive and gastrointestinal surgery in dogs.[8–11] Laparoscopic ovariectomy and laparoscopic-assisted ovariohysterectomy have been described in bitches and the benefits have been established, including excellent perioperative surgical viewing, decreased surgical stress, postoperative pain, and morbidity and a faster return to normal activity.[12–13] Ventral median celiotomy techniques are more painful than laparoscopic or laparoscopy-assisted ovariectomy and ovariohysterectomy.[13–16]

In contrast to dogs, few studies on laparoscopic surgery in cats have been reported. Laparoscopic procedures reported include ovariectomy[17]; cryptorchidectomy[10]; adrenalectomy[18]; laparoscopic-assisted colopexy[19]; and abdominal organ biopsy.[20] Only 1 study reported the association with pain[21] because pain may be especially difficult to evaluate in cats. Clinical trials comparing postoperative pain after laparoscopic and open approaches for ovariectomy in cats have not been reported.

Our purpose was to compare postoperative pain, duration of surgery, and duration of anesthesia in a prospective clinical trial of 3 ovariectomy approaches in cats: (1) conventional ventral median celiotomy; (2) unilateral right flank laparotomy; and (3) a midline 2-portal laparoscopic approach. We hypothesized that similar to dogs, laparoscopic ovariectomy would cause less postoperative pain than open median celiotomy and flank laparotomy approaches and that other variables would be similar between groups.

MATERIALS AND METHODS

Study Population

Healthy female cats (n = 60) scheduled for elective ovariectomy were enrolled in this prospective study after obtaining owners' written consent and approval from the local Animal Welfare committee.

Cats were considered healthy based on history, clinical examination, and hematologic examination on admission and were subsequently classified as American Society of Anesthesiologists (ASA) category ASA 1. To be included, cats had to have a suitable temperament and not have been administered analgesics within 48 hours of surgery. Behavioral assessment was performed, classifying the cat as docile, anxious, or aggressive, to ensure patient cooperation and a baseline pain score was established (see below). Aggressive cats were excluded from the study.

Cats were admitted the day before surgery and discharged the day after surgery. Food but not water was withheld beginning the night before surgery. Cats exhibiting uncontrollable pain during the study (described as requiring more than 0.5 mg/kg/h intravenous [IV] morphine) or a significant change in their health status requiring treatment during or within the 24 hours after surgery were excluded.

Cats were randomly assigned, using a computer generated randomization list, to 1 of 3 ovariectomy approaches: conventional ventral median celiotomy (Midline group), unilateral right flank laparotomy (Flank group), or a midline 2-portal laparoscopy (Lap group).

Anesthesia

Fifteen minutes after premedication (15 μg/kg medetomidine combined with 0.1 mg/kg morphine hydrochloride administered intramuscularly), anesthesia was induced with propofol IV to effect, and the dose required to allow endotracheal intubation was recorded. Anesthesia was maintained with isoflurane in 100% oxygen delivered through a non-rebreathing circuit. Breathing was spontaneous. The percentage of inhaled isoflurane was tailored to the needs of each cat, based on the clinical signs of surgical anesthesia (reflex abolition, eye position, pupil diameter, muscle relaxation). Lactated Ringer's solution was administered during surgery (10 mL/kg/h IV) and cefalexine (30 mg/kg IV) was administered immediately before surgery.

Cats were initially positioned in dorsal recumbency, on a circulating warm water blanket. Perioperative monitoring (Datex Ohmeda S5, Datex-Ohmeda, Inc., Madison, WI) consisted of electrocardiogram (ECG), heart rate (HR), respiratory rate (RR), body temperature (BT), end tidal isoflurane (ETiso), and end tidal carbon dioxide ($ETCO_2$) measurements and ultrasonic Doppler measurement of systolic blood pressure. Morphine hydrochloride (0.05 mg/kg IV) was administered perioperatively for analgesia as required without exceeding 0.5 mg/kg/h. Monitoring measurements and analgesic administrations were recorded on each cat's anesthetic record.

Surgical Procedures

All open procedures were performed by 1 senior surgeon and all laparoscopic procedures by another senior surgeon. Surgical assistants were different veterinary students.

Ventral Median Celiotomy Ovariectomy

Median celiotomy was performed through a 3–4 cm long skin and linea alba incision. A sterile sponge was introduced into the peritoneal cavity to retract the digestive viscera. The right uterine horn was identified and grasped, and the right ovary exteriorized from the peritoneal cavity. The broad ligament was punctured and 2 Halstead forceps were placed, 1 at the cranial aspect of the ovary across the suspensory ligament and mesovarial pedicle and 1 at the caudal aspect of the ovary across the proper ligament of the ovary and cranial uterine artery. One 3–0 polyglactin 910 ligature was placed beneath each forceps and the tissue above each forceps transected to complete ovariectomy. The clamps were released, hemostasis checked, the right uterine horn returned to the abdominal cavity and followed to the uterine bifurcation to identify the contralateral horn. The procedure was repeated for the left ovary. The celiotomy was closed in layers (interrupted 3–0 polyglecaprone 25 sutures in the linea and subcutaneous tissues; simple interrupted 3–0 polyamid sutures in the skin).

Right Flank Ovariectomy

With the cat positioned in left lateral recumbency, a 2–3 cm long skin incision was performed in a caudoventral oblique direction, starting caudally to the palpable right kidney. The abdominal wall musculature and peritoneum were bluntly punctured and small sized retractors placed. The right ovary was identified, exteriorized, and excised as described. The right uterine horn was followed to the uterine bifurcation to identify the contralateral horn and the left ovary exteriorized and excised. Hemostasis was checked and the laparotomy closed in layers.

Laparoscopic Ovariectomy

With the cat in dorsal recumbency, a sutureless modified Hasson technique was used to establish pneumoperitoneum through the laparoscope portal. Briefly, through a 5–6 mm midline skin incision, the camera portal was established 1 cm caudal to the umbilicus using a 6.5 cm long, 6 mm trocarless threaded cannula (Ternamian Endotip™, Karl Storz Veterinary Endoscopy, Karl Storz Endoskope, Karl Storz GmbH & Co. KG, Tuttlingen, Germany). Once the trocar was inserted, the abdomen was insufflated with CO_2 to a maximum pressure of 4 mmHg. Laparoscope (5 mm, 0°, 29 cm Hopkins II laparoscope®, Karl Storz Veterinary Endoscopy) introduction was immediately followed by abdominal exploration and the instrument portal was placed under direct observation. This 2nd portal was established between the xiphoid cartilage and umbilicus with a disposable 6 mm threaded trocar-cannula assembly. After portal placement, the cat was rotated to achieve an almost 90° left lateral recumbency to facilitate right ovary identification. Trendelenburg positioning was not used.

The right ovary was grasped with a 5-mm laparoscopic Babcock forceps and lifted toward the abdominal wall to provide optimal viewing of the ovarian vasculature and ligaments. A transabdominal ligature (3–0 polyglecaprone 25) was percutaneously positioned by laparoscopic guidance under the ovary and tied extracorporeally to isolate the ovarian pedicle. The grasping forceps were withdrawn and a 5 mm endoscopic bipolar vessel-sealing device (Ligasure^{TM}, Covidien, Mansfield, MA) introduced through the instrument portal to provide hemostasis and section of the supporting tissues of the ovary. Usually, 2–3 applications of the vessel-sealing device were necessary to section the proper ligament, ovarian vessels, and suspensory ligament. The sealing forceps was kept in neutral position and used to grasp the ovary, the transabdominal suture was released and the ovary was withdrawn through the instrument portal. The cat was rotated into right lateral recumbency and the procedure repeated to remove the left ovary. Portal sites were sutured with one 3–0 monofilament absorbable suture and one 3–0 monofilament nonabsorbable suture for skin closure.

Recorded Variables and Postoperative Pain Assessment

Surgical and postoperative complications were recorded for all procedures. Duration of surgery, duration of anesthesia, and duration of recovery were recorded for each cat. Duration of surgery was defined as time from 1st skin incision to last skin or portal suture. Anesthesia duration was defined as time from induction to endotracheal extubation. Duration of recovery was defined as time from extubation to voluntary sternal recumbency. The quality of the recovery was subjectively assessed as delayed, agitated, or good. The level of postoperative consciousness was recorded by the anesthetist 1 hour after end of anesthesia, before the 1st postoperative evaluation, and cats were classified as awake and mobile, in sternal recumbency or in lateral recumbency.

Cats were clinically evaluated at 1, 2, 4, 6, and 12 hours after extubation; this included HR, RR, BT, and pain score (PS). On each clinical evaluation, the intensity of postoperative pain was initially scored from 0–18 using the 4A-Vet composite pain scale[22–27] (Appendix). Three levels of pain were defined: weak (level 1; PS = 1–5), moderate (level 2; PS = 6–10), and severe (level 3; PS = 11–18). Additional postoperative analgesia was provided as required according to PS ($\geq$6) by administration of morphine (0.05 mg/kg IV), repeated after 5 minutes as needed, up to a maximum dose of 0.5 mg/kg/h. The number of postoperative morphine injections was recorded for each cat. If the PS was $\geq$6 after the maximum dose of morphine, the cat was excluded from the study and adequate analgesia was provided using more potent opioids or different analgesics.

The cat's appetite 6 hours after extubation was evaluated by offering wet and dry food.

At 12 hours, cats were transferred to the ICU, after the last postoperative evaluation. Additional rescue analgesia with opioids or nonsteroidal anti-inflammatory drugs was available and then administered on an individual basis when necessary (data not recorded).

Expression of the Results and Statistical Analysis

The following variables were compared between groups: age, body weight, preoperative behavior, duration of anesthesia, duration of surgery, duration of recovery, dose of propofol for induction of anesthesia, number of perioperative and postoperative morphine injections, quality of recovery, level of postoperative consciousness, HR, RR, BT, PS preoperatively and at each of the postoperative examination time points.

For quantitative variables, mean $\pm$ SD were calculated at each stage of the examination. Statistical analysis was performed using 1-way ANOVA, followed by a post hoc Tukey test for pairwise multiple comparisons. Pain scores were considered as continuous data. The effects of surgical procedure, time, and perioperative morphine boluses on PS were established with a linear mixed effects model to take into account the repeated measurements design. A post hoc Tukey test adapted for mixed effects was used to assess comparisons of means of PS in the 3 groups. Qualitative variables were compared using a Fisher exact test. Data analysis was performed using statistical software (R-project software; R Development Core Team, version 2.13.0, R Foundation for Statistical Computing, 2011). Significance was set at $P < .05$.

RESULTS

Study Population

Sixty-eight, ASA 1, domestic shorthair cats (consecutive cases) were initially enrolled: 23 cats in the Midline group, 21 in the Flank group and 24 in the Lap group. Three cats were excluded from the Midline group: 1 for deviation from the protocol, 1 required ephedrine to treat marked hypotension; and 1 became aggressive after recovery and could not be examined. One cat was excluded from the Flank group because it became aggressive after recovery and could not be examined. Four cats were excluded from the Lap group: 1 was pregnant, 1 had a uterine abnormality requiring ovariohysterectomy, 1 for breach of protocol, and 1 because *Hemobartonella* infection was detected postoperatively. Thus, there were 3 groups, each of 20 cats. None of the cats was excluded because of inadequate postoperative analgesia.

There were no significant differences in mean group ages: Midline, 8.3 months; Flank, 10.2 months; and Lap, 11.0 months (Table 1). Mean weight for Midline (2.7 kg) and Lap (2.62 kg) groups were not significantly different but both were significantly less than mean weight of the Flank group (3.14 kg; Flank–Lap: $P = .004$; Flank–Midline: $P = .019$).

Preoperative Variables

All cats were classified as either docile or anxious during preoperative examination, without any significant difference between groups. Preoperative HR, RR, and BT of the cats were not significantly different between groups. All cats had an initial pain score of zero.

Anesthesia and Surgical Procedures

Doses of medetomidine and opioids were set by protocol and were identical for the 3 groups. Significantly fewer doses of

Table 1 Recorded Quantitative Data of the Three Studied Groups

	Midline Group (n = 20)	Flank Group (n = 20)	Lap Group (n = 20)
Age (months)	8.3 ± 0.8 [5–19]	10.2 ± 1.3 [6–28]	11.0 ± 1.7 [6–33]
Body weight (kg)	2.70 ± 0.39 [2.0–3.6]	3.14 ± 0.61 [1.8–4.5]	2.62 ± 0.47* [1.8–3.6]
Duration of anesthesia (min)	80 ± 13 [54–100]	72 ± 11 [55–95]	113 ± 15* [81–149]
Duration of surgery (min)	35 ± 9 [20–49]	24 ± 9 [12–48]	41 ± 6* [34–54]
Duration of recovery (min)	21 ± 22 [2–90]	11 ± 14 [1–54]	12 ± 20 [1–80]
Doses of propofol for induction (mg/kg)	4.76 ± 2.01* [2.42–9.58]	3.40 ± 1.11 [1.43–6.03]	3.66 ± 1.82 [1.50–9.09]
Number of perioperative morphine boluses (0.05 mg/kg per bolus)	1.80 ± 1.54 [0–7]	1.85 ± 1.18 [0–4]	1.95 ± 0.91 [1–4]
Preoperative body temperature (°C)	38.6 ± 0.6 [37.0–39.6]	38.5 ± 0.8 [36.3–39.8]	38.6 ± 0.5 [37.9–39.5]
Postoperative body temperature (end of surgery)	37.4 ± 0.9 [36.0–39.2]	37.5 ± 0.9 [36.2–39.1]	36.8 ± 1.0* [35.2–39.4]

Results are expressed as mean ± SD with minimum and maximum values in brackets (* $P < .05$).

propofol were administered to the Flank group ($P = .036$) compared with the Midline group, and there were no significant differences between Lap and Flank groups or Lap and Midline groups.

There was a significant difference between anesthesia duration for Midline and Lap, and between Flank and Lap ($P = .0001$) groups. Cats in all groups were administered an average of ~2 additional doses of morphine during surgery without any significant difference between groups.

Cats in the Lap group had a significantly lower BT (36.8°C; $P = .033$) at the end of surgery compared with Flank (37.5°C) and Midline (37.4°C) which were not significantly different from each other. BT was not significantly different between groups at the end of anesthesia and at the end of recovery.

No surgical complications were reported. Conversion to an open approach was unnecessary in the Lap group. Mean ± SD surgical time was significantly longer for Lap (41 ± 6 min) compared with Midline (35 ± 9 min; $P = .019$) and Flank (24 ± 9 min; $P = .001$) (Table 1).

Postoperative Evaluation and Pain Assessment

There was no significant difference in the subjective quality of recovery between groups. One hour after extubation, most cats were fully awake, without any significant difference between levels of consciousness of cats in the 3 groups. Duration of recovery was not significantly different between groups.

Appetite was not significantly different between different groups 6 hours after extubation. There was no significant difference between groups for BT or HR at any measurement time point. Similarly, there was no significant difference in HR variations in the groups between preoperative and postoperative values. Similar results were observed for RR between groups. The number of postoperative morphine injections was significantly lower in Lap (0.55 ± 0.61) than in Midline (2.30 ± 2.39; $P < .001$) and Flank (3.25 ± 3.18; $P < .001$) but not significantly different between Midline and Flank groups.

Postoperative Pain Scores

Most cats in the Lap group had weak pain (50% at 1 hour to 95% at 12 hours) postoperatively. None of the cats in this group had intense postoperative pain (Fig 1). Between 35% and 60% of Midline cats had weak pain postoperatively; a maximum of 5% had intense pain (Fig 2). For the Flank group, a maximum of 50% had weak pain (Fig 3), and depending on the time, 5–20% had intense pain.

The linear mixed effects model showed that (1) there was a significant difference in the PS between groups; (2) PS increased significantly with the number of perioperative morphine boluses ($P < .0001$); (3) PS seemed to decrease with time ($P = 0.053$); and (4) there were no interactions between surgical group and time or between the number of morphine boluses and time producing an effect on pain scores. Hence, PS were significantly lower for Lap compared with Midline ($P < .001$) and PS for Lap were significantly lower compared with Flank ($P = .016$; Table 2). PS in Midline group and Flank group did not differ significantly.

DISCUSSION

Using the 4A-Vet pain scale, we found that laparoscopic ovariectomy (Lap) was the least painful procedure and that there was no significant difference in pain scores between the celiotomy and laparotomy approaches to ovariectomy. To our knowledge, this prospective clinical study is the first comparing postoperative pain after laparoscopic and open approaches for ovariectomy in cats.

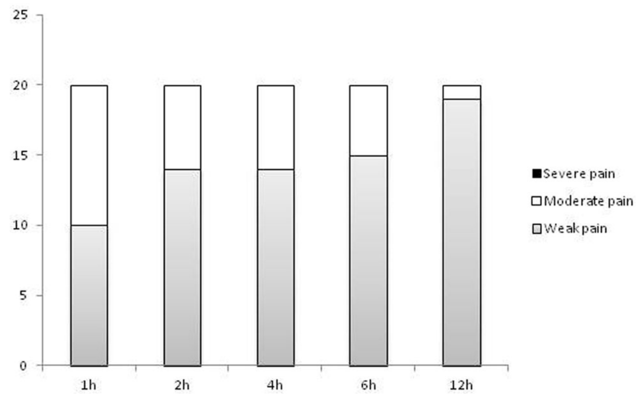

Figure 1 Pain score distribution 1, 2, 4, 6, and 12 hours postoperatively in the Lap group (n = 20).

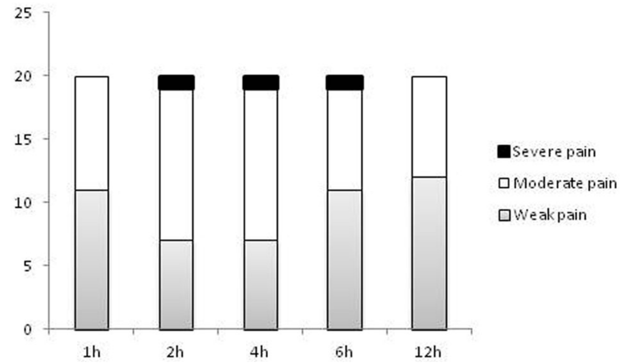

Figure 2 Pain score distribution 1, 2, 4, 6, and 12 hours postoperatively in the Midline group (n = 20).

Despite a significant difference in mean weight of the cats, the groups we studied were quite homogenous in age, temperament, and initial clinical examination findings. Postoperative assessment may be complicated by different factors related to sedation, anesthesia, and perioperative analgesia.[28] Although we observed a significant difference in the dose of propofol administered between groups, this difference did not influence analgesia during surgery as propofol only enabled endotracheal intubation with no prolonged analgesic effects. Moreover, there was no significant difference in the number of morphine injections per cat perioperatively between groups.

Surgical Technique

The flank approach was fastest (mean surgical duration, 24 minutes) and surgical time was significantly longer for laparoscopic ovariectomy (mean, 41 minutes). These relative times should be viewed in light of the fact that this study was performed at a university hospital where surgical assistants were undergraduate students. Body temperature was significantly lower in the Lap Group at the end of surgery, but this difference between groups was no longer significant at the end of anesthesia and thereafter. This difference in BT may be because of a significantly longer duration of anesthesia in the Lap group but also because the laparoscopic procedure induced only a transient hypothermia.

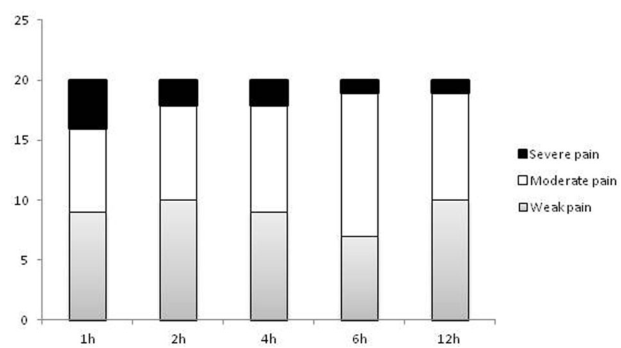

Figure 3 Pain score distribution 1, 2, 4, 6, and 12 hours postoperatively in the Flank group (n = 20).

Table 2 Results of the Postoperative Pain Scores Comparison With the Post Hoc Tukey Test

Surgical Groups	Estimation of the Difference in Means	Standard Error of the Difference in Means	*P*-Value in Post Hoc Tukey Test
Flank–Lap	1.11	0.403	.016
Midline–Lap	1.66	0.402	<.001
Midline–Flank	0.55	0.376	.309

In dogs, 2-portal or 3-portal access was first reported for both ovariectomy and ovariohysterectomy.[8,9] As reported in dogs,[29] laparoscopic ovariectomy with single portal access is feasible and safe in cats, with a 12 mm umbilical portal.[21] The authors reported a mean surgical time of 23 minutes which is similar to the flank and midline approach we performed but compares favorably to our laparoscopic approach.[21] They also reported postoperative pain scores obtained using a visual analog scale (VAS) method that did not indicate any need for additional pain medication for any of the cats.[21] Our 2-portal access necessitated limited incisions of ~6 mm each which is very close to that needed for single-portal access. Although an intra-abdominal CO_2 pressure of 12 mmHg is considered safe in healthy cats,[30] we found that a CO_2 insufflation pressure as low as 4 mmHg was sufficient to provide excellent surgical viewing and adequate instrument handling. Such a low pressure has been used in cats[17] and may also influence postoperative pain. In our study, this pressure remained compatible with spontaneous breathing used for all open and laparoscopic procedures.

Postoperative Pain Assessment and Scores

Postoperative pain assessment may be particularly difficult in cats because they can be poorly tolerant of the handling required for the repeated clinical examinations. The level of postoperative consciousness can affect evaluation of postoperative pain using the 4A-Vet scale, because it is notably based on the general attitude of the cat. The 4A-Vet scale combines a subjective numerical pain rating and an objective score of physiologic and behavioral variables,[31] including response to stimulation of the surgical site.[32] It has been validated in dogs for osteoarthritic pain, postoperative pain, and pain related to standardized bone marrow aspiration procedures.[21–23,28]

We found no significant difference in the quality or duration of recovery between groups. Most cats were fully awake within a short time after extubation and ate spontaneously 6 hours after recovery.

Physiologic variables can be poorly related with postoperative pain unlike behavioral reactions and local pain at the surgical site. We found that HR and RR did not appear to be good discriminating factors for assessing postoperative pain. There was no significant difference in HR and RR between groups at any time point postoperatively and no significant difference between pre- and postoperative values. There was however a highly significant difference in PS between the Lap group and the Flank and Midline groups, the former having lower PS. Most cats in the Lap group had weak pain throughout the postoperative period, and none of the cats in this group had signs of intense pain. At 12 hours, ~50% of cats in both Midline and Flank groups still exhibited moderate pain. Similar differences between groups were observed with the number of postoperative morphine injections. Postoperative morphine injections were direct consequences of PS as any cat with moderate and severe pain (PS >6) was administered at least 1 morphine dose.

Although sizes of skin and abdominal wall incisions were not recorded, reducing abdominal wall trauma did not seem to be a key factor in reducing postoperative pain, as already reported in dogs.[12] The flank and laparoscopy techniques required smaller incisions than required for median celiotomy, but the flank approach, although fastest, also seemed to be the most painful, despite limited skin, and muscular surgical damage. On the contrary, for the 2 open approaches, the ovaries had to be exteriorized and their ligaments considerably extended to allow extracorporeal ligation. Such abdominal organ handling may contribute to higher postoperative pain that did not differ significantly between the 2 open approaches as already reported.[6]

The ligation technique used for the ovarian pedicles may also influence postoperative pain.[15,33,34] In dogs, the use of bipolar vessel-sealing devices has been associated with significantly shorter surgical times and a lower incidence of hemorrhage from the ovarian pedicle.[9] Laser and bipolar electrocoagulation have been used in laparoscopic ovariectomy in dogs and cats.[17,21,35,36] Intra-abdominal blood loss was not documented in our study but it was minimal for both open approaches and, with the use of the bipolar vessel-sealing device, intraoperative hemorrhage did not occur during the laparoscopic procedures.

Most studies comparing the pain induced by different neutering techniques have been conducted in bitches. Open midline ovariohysterectomy and ovariectomy were more painful postoperatively than laparoscopic-assisted ovariohysterectomy and ovariectomy.[13,14,16] A longer incision for median celiotomy and the use of bipolar electrocoagulation during laparoscopy may explain such results.[15] Many studies report that laparoscopic procedures are slower than traditional midline open technique,[13,14] with the exception of a study on ovariohysterectomy in bitches.[15] Like other endoscopic procedures, laparoscopic ovariectomy in cats requires specialized equipment and training for both the primary surgeon and surgical assistants.

The lack of a blinded investigator for postoperative pain evaluation is the main limitation of our study. As response from the cats to palpation of the surgical site was a major criteria for postoperative pain assessment, and considering that the 3 techniques intrinsically did not have the same skin incisions, it was not possible to achieve a blinded evaluation. The postoperative investigator was neither a member of the surgical team nor the anesthesia team and was unaware of the recorded preoperative and perioperative variables related to the surgical procedures. Another limitation is that all surgical procedures were performed with inexperienced veterinary students as surgical assistants because ovariectomy in cats is a major part of their surgical training. None of them were familiar with the handling of the endoscope. This could account for the long surgical times we observed in all groups. The surgeons' experience, the incision length, and the duration of surgery were not reported to influence postoperative pain after open neutering procedures in bitches.[12] Our findings in cats fully confirmed these results. In our study, despite the lack of training, it was never necessary to convert the primary laparoscopic approach to a conventional open celiotomy, and laparoscopic ovariectomy was of great value in providing students with a dynamic description of surgical anatomy.

The 4A-Vet pain scale we used in this clinical study enabled us to detect postoperative pain after ovariectomy in cats. Laparoscopic ovariectomy, although slower, appeared to be the least painful technique compared with both midline and flank ovariectomy. Postoperative pain did not differ significantly between the 2 open approaches. Like dogs, cats may benefit from laparoscopic procedures.

DISCLOSURE

The authors report no financial or other conflicts related to this report.

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APPENDIX A. POSTOPERATIVE PAIN EVALUATION SCALE

The final pain score is the sum of the scores for each criteria (adapted from the 4A-VET pain scale in cats; www.avet.org).

Studied Criteria	Modifications	Score
Subjective global evaluation	From No pain to Severe pain	From 0 to 3
General attitude	Within the following symptoms:	
	- Modification of respiration	
	- Vaulted back	
	- Antalgic posture	
	- Abnormally agitated or depressed	
	- Loss of grooming	
	- Look at or lick the operated area	
	- Urinate or defecate on itself	
	- Loss of appetite	
	If none is present	0
	If 1 is present	1
	If 1 to 4 are present	2
	If more than 4 are present	3
Interactive demeanor	Attentive to cares and human voice	0
	Timid response to cares	1
	No response to cares	2
	Aggressive response	3
Heart rate	Increase from initial value <10%	0
	Increase of 11–30%	1
	Increase of 31–50%	2
	Increase >50%	3
Reaction to manipulation of surgical area	No perceptible reaction after 4 manipulations	0
	Perceptible reaction:	
	- after the 4th manipulation	1
	- at the 2nd or 3rd manipulation	2
	- at the 1st manipulation	3
Intensity of this reaction	No reaction	0
	Try to escape	1
	Groan, turn its head	2
	Try to bite	3
Global pain score (1–18)		1–5: weak pain 6–10: moderate pain 11–18: severe pain

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