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# Laparoscopic ovariectomy in dogs: comparison between laparoendoscopic single-site and three-portal access

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This study was conducted to evaluate the feasibility and therapeutic safety of laparoendoscopic single-site ovariectomy (LESS-OVE) and 3-portal laparoscopic ovariectomy (Lap-OVE) in dogs. Ten female mixed breed dogs were included in the study. Dogs were divided into group 1 (LESS-OVE; n = 5) and group 2 (Lap-OVE; n = 5). All procedures were performed by laparoscopic-skilled surgeons, and the anesthetic protocol was the same for all patients. In both groups, the ovarian vascular pedicle and ligaments were transected using a bipolar vessel sealer/divider device. The mean total surgical time was slightly longer in LESS-OVE (36.6 ± 3.5 min) than Lap-OVE (32.0 ± 3.0 min); however, the differences were not significant. Perioperative complications were not reported in any group. Both laparoscopic techniques were shown to be equally feasible and safe for patients. However, surgeons found LESS-OVE to require more skill than Lap-OVE. Therefore, additional studies should be conducted to evaluate this novel approach in clinical veterinary practice, and a proper laparoscopic training program for veterinary surgeons should be developed.

**Keywords:** dogs, laparoendoscopic single-site, laparoscopy, minimally invasive surgery, ovariectomy

## Introduction

Minimally invasive surgery, especially laparoscopic surgical techniques, are increasingly being used in both human and veterinary surgery because of their reported advantages (less surgical trauma, less postoperative pain, rapid return to normal activity, shorter hospitalization times) when compared with open procedures [23]. One of the main disadvantages of laparoscopic surgery is the need to learn new surgical skills. These techniques present a steep learning curve, which has to be reached gradually and ethically by means of simulators and/or using animal model training programs [24]. The latter is time consuming and represents an important financial limitation. Soft tissue surgery in veterinary medicine follows the same shift to minimally invasive surgery as in human medicine. Currently, veterinary practitioners are becoming more aware of the advantages, and a slow, but steady evolution and refinement of minimally invasive techniques in small animal practice is occurring [18,19].

Single port access is a new laparoscopic technique that has been developed as an alternative to 2 or 3 portal traditional laparoscopic techniques in an effort to potentially reduce morbidity and hospitalization [8,30]. Reducing portal size and number is currently gaining popularity in human medicine. However, this is associated with increased technical difficulty, which in turn can lengthen surgical times and increase perioperative complications, especially in less trained surgeons [32].

Elective sterilization in dogs and cats is one of the most common procedures performed in veterinary practice. Since 1985 [36], different genital laparoscopic techniques have been evaluated in dogs, as well as laparoscopic ovariectomy, laparoscopic ovariohysterectomy and laparoscopic-assisted ovariohysterectomy [1,15,35]. These techniques have gained acceptance because of their demonstrated advantages, which include less postoperative pain, less morbidity and a rapid return to normal activity [10]. Ovariohysterectomy has historically been the sterilization technique of choice in small animals [4]. However, there is no scientific evidence for the preferential use of ovariohysterectomy over ovariectomy [9], and some studies have demonstrated that ovariectomy potentially induces less surgical trauma (smaller incisions, better viewing of the ovarian pedicle, and possibly less risk of complications associated with surgical manipulation of the uterus) and reduced surgical and

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anesthetic times [27,34].

This study was conducted to evaluate the feasibility and therapeutic safety of laparoendoscopic single-site ovariectomy (LESS-OVE) and 3-portal laparoscopic ovariectomy (Lap-OVE) in dogs based on surgical times, perioperative complications, patient recovery and follow-up, as well as a surgeon's subjective assessment of both laparoscopic techniques.

## Materials and Methods

### Ethical considerations

All procedures were approved by the Ethical Commission of Animal and Human Experimentation of the "Jesús Usón" Minimal Invasive Surgery Center (JUMISC). All animals were kept and procedures were performed in accordance with the Spanish Government for Animal Care guidelines (RD 53/2013).

### Study design

All procedures were performed by two veterinary surgeons experienced in minimally invasive techniques. Initially, a training period was accomplished using a physical simulator conduct LESS dissection, cutting and suturing maneuvers.

Ten intact female mixed breed dogs were included in the study, which was performed in the JUMISC. Dogs were randomly assigned to group 1 (LESS-OVE; n = 5) and group 2 (Lap-OVE; n = 5) for laparoscopic ovariectomy. All dogs included in the study underwent complete physical examination and had no previous or current history of illness. Blood count and serum biochemical profile were performed before surgery. Food was withdrawn twelve hours before surgery. The cephalic vein was catheterized to enable administration of the anesthetic agents and fluids during surgery.

The anesthetic protocol used was the same for all animals. Dogs were premedicated using dexmedetomidine (Esteve, Spain) 10 mcg/kg intramuscular injection (im). After a short period of pre-oxygenation using a hall face mask, anesthesia was induced using propofol (Sandoz, Spain) dosed to effect (1−4 mg/kg, intravenous [iv]), and tracheal intubation was performed. Anesthesia was maintained by inhalation of sevofluorane (Abbott Laboratories, UK) at a 1.25 minimum alveolar concentration (MAC) (1 MAC = 2.36%) combined with 100% oxygen via a semi-closed anesthetic system. Volume controlled mechanical ventilation was conducted to maintain normocapnia ($EtCO_2$ from 35 to 40 cm $H_2O$), leading to a respiratory rate of 20 rpm. Ketorolac tromethamine (1 mg/kg iv; Normon, Spain), tramadol (2 mg/kg iv; Grünenthal Pharma, Spain) and amoxicillin (15 mg/kg im; Ceva, Spain) were administered before surgery. Throughout the procedure, respiratory and cardiac rate, pulse-oximetry, $FiO_2$, $EtCO_2$, tidal volume per minute, inhaled and exhaled anesthetic agent and airway peak pressure were monitored with a multi-parametric monitor (Dash 3000; GE Healthcare, USA).

Before starting surgery, the hair on the abdomen was clipped and aseptically prepared for laparoscopic surgery, and the urinary bladder was emptied by catheterization. The animal was positioned in dorsal recumbency.

**Group 1 (LESS-OVE):** A 3 cm vertical skin incision was performed at the peri-umbilical area to expose the linea alba, and after blunt dissection of all abdominal layers, a single access device (SILS Port; Covidien, USA) that had been previously lubricated (K-Y; Johnson & Johnson, USA) was placed in the abdominal wall using a Doyen clamp (Fig. 1). Next, three laparoscopic 5 mm cannulas were introduced through the access channels of the single access device. Pneumoperitoneum was established with an electronic insufflator to 10 mmHg with a flow rate of 1 L/min using $CO_2$. Complete exploration of the abdominal cavity was performed with a 5 mm 30 laparoscope 50 cm in length (Laparoscope HOPKINS II; Karl Storz, Germany), followed by patient placement in the right lateral recumbency with slight lumbar elevation to facilitate exposure of the left ovary and uterine horn. Both surgeons were positioned on the right side of the operating table.

The left ovary was identified and a 5 mm grasping forceps was introduced through the operating channel to pull the ovary up. Using a 5 mm laparoscopic vessel sealer/divider device (LigaSure V; Valleylab; Covidien, Austria), the proper ovarian ligament, ovarian pedicle and suspensory ligament were progressively sealed and transected. Once the left ovary was completely transected, one laparoscopic cannula of 5 mm was removed and replaced by one 10 mm laparoscopic cannula to facilitate ovary exteriorization. The dog was then positioned in left lateral recumbency and ovariectomy was repeated on the right side using the same technique. Immediately after removal,

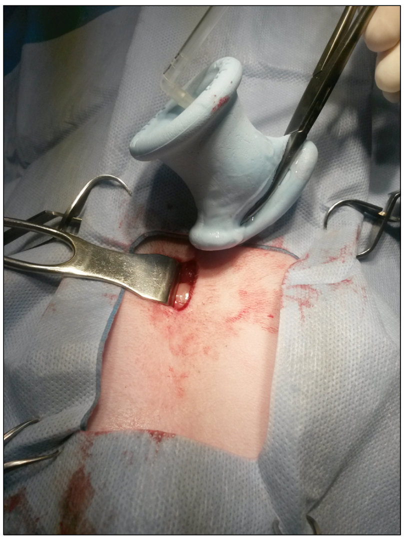

**Fig. 1.** Insertion of the LESS Port under visual control.

the ovaries were checked to ensure complete removal and pneumoperitoneum was released. The abdominal incision was closed in 3 layers using a 3/0 USP braided absorbable material (Polysorb 3/0; Covidien, USA) and a simple interrupted suture pattern.

**Group 2 (Lap-OVE):** A skin incision approximately 1 cm long was made 1 to 2 cm caudal to the umbilicus. The first 10 mm portal was inserted using an open technique and the pneumoperitoneum was established through this portal. Two 5 mm portals were then inserted in the linea alba about 5 and 7 cm cranial and caudal to the first portal, respectively. A 5 mm diameter, $30^o$ angle of vision telescope (Laparoscope HOPKINS II; Karl Storz) was used and a thorough inspection of the abdominal cavity was performed. In right lateral recumbency, the left ovarian pedicle, proper ligament, and suspensory ligament were sealed and transected as described for the LESS-OVE technique (Fig. 2). The ovary was pulled through the 10 mm portal under direct visualization. After re-establishing the pneumoperitoneum, and with the dog repositioned in left lateral recumbency, right ovariectomy was performed using the same technique as described above. Immediately after removal, the ovaries were checked to ensure complete removal and the pneumoperitoneum was released. The three portals were removed and abdominal incisions closed in 3 layers using a 3/0 USP braided absorbable material (Polysorb 3/0; Covidien) and a simple interrupted suture pattern.

When the surgical procedure was completed in both groups, dogs received a single dose of buprenorphine (Richter Pharma, Austria) (0.03 mg/kg iv) and meloxicam (Virbac, Irland) (0.1 mg/kg SC) every 24 h during 3 days. To detect postoperative complications, physical examination and wound inspection was daily performed for 10 days.

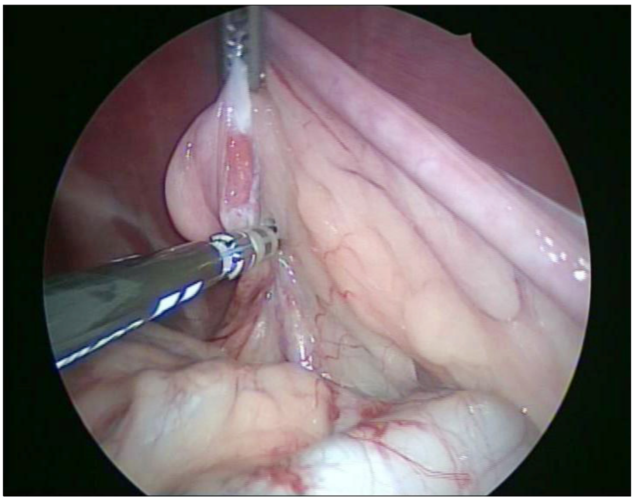

**Fig. 2.** Exposure and coagulation of the ovarian pedicle area accomplished by traction of the proper ovarian ligament.

### Recorded data

Total surgical time (defined as the time elapsed from the 1st portal placement until skin closure) and surgical wound length measurements were recorded. Information about weight and body condition scores (on a 5 grade scale) was collected. Other data registered included fat scores of the ovarian ligament and perioperative complications such as bleeding from the ovarian bursa, from the ovarian pedicle, or from the proper ligament. After each procedure, all surgeons were invited to fill out a questionnaire to evaluate the degree of difficulty of the surgical approaches. A one to five point Likert scale was used, with 1 being the lowest level of difficulty and 5 the highest.

### Statistical analysis

All analyses were performed with the statistical software package for Windows (SPSS ver. 15.0; SPSS, USA). Normally distributed variables are reported as the mean ± SD (Shapiro-Wilk test). We used an unpaired t-test to compare surgical times and surgical wound length in the 2 study arms. Categorical data were analyzed with a $\chi^2$ test (body score, fat score of the ovarian ligament, ovarian bleeding events). The level of significance was set at $p < 0.05$.

## Results

A total of ten mixed-breed dogs were included in the study. The mean age for group LESS-OVE and group Lap-OVE was 3.4 ± 1.1 years and 3.2 ± 1.1 years, respectively, while the mean weight was 12.0 ± 3.5 kg (range, 6.5−16 kg) for group LESS-OVE and 13.0 ± 2.0 kg (range, 7.5−15 kg) for group Lap-OVE. Two dogs were classified as underweight (body condition score: 1−2), seven dogs as normal weight (body condition score: 3), and one as overweight (body condition score: 4). The amount of fat in the ovarian pedicle did not influence the operative time in either group.

Data for total surgical time and surgical wound length measurements are shown in Tables 1 and 2 for LESS-OVE and Lap-OVE, respectively. There was no significant difference

**Table 1.** Total surgical time and surgical wound length measurements (LESS-OVE)

| Case | Total surgical time (min) | Surgical wound length (cm) |
|---|---|---|
| 1 | 38 | 3.0 |
| 2 | 42 | 3.1 |
| 3 | 35 | 2.9 |
| 4 | 34 | 3.0 |
| 5 | 34 | 3.1 |
| (Mean ± SD) | 36.0 ± 3.5 | 3.0 ± 0.1 |

**Table 2.** Total surgical time and surgical wound length measurements (Lap-OVE)

| Case | Total surgical time (min) | Surgical wound length (cm) |
|---|---|---|
| 1 | 35 | 2.2 |
| 2 | 33 | 2.0 |
| 3 | 28 | 2.4 |
| 4 | 30 | 2.2 |
| 5 | 34 | 2.5 |
| (Mean ± SD) | 32.0 ± 3.0 | 2.2 ± 0.2 |

between groups ($p$ = 0.052) for total surgical time. The mean total surgical time was 36.6 ± 3.5 minutes (range 34–42 min) for group LESS-OVE, and 32.0 ± 3.0 minutes (range 28–35 min) for group Lap-OVE. Surgical time was not correlated with weight ($R^2$ = 0.104 for LESS-OVE and $R^2$ = 0.073 for Lap-OVE) or age ($R^2$ = 0.391 for LES-OVE and $R^2$ = 0.432 for Lap-OVE), and thus not related to the amount of fat of the ovarian pedicle. The mean surgical wound length for group LESS-OVE was 3.0 ± 0.1cm (range 2.9–3.1 cm), while it was 2.2 ± 0.2 cm (range 2.0–2.4 cm) for group Lap-OVE ($p \leq 0.001$).

No lesions or hemorrhages were observed during the laparoscopic procedure, and ovaries were removed without incidence. No relevant hemodynamic changes were observed as a result of pneumoperitoneum or surgery. All dogs recovered from anesthesia uneventfully and within 30 min after switching off the sevofluorane vaporizer. No immediate or mid-term postoperative complications, swelling or signs of pain were observed during patient examination.

The same surgeons performed all surgical procedures. Surgeons completed a subjective survey describing their experience with both laparoscopic techniques. Ovariectomies performed by LESS-OVE received a mean score of 2.4 points in almost all of the survey questions, which indicates to a medium level of difficulty, except for evaluation of maneuverability and/or instrument collision, for which a mean of 3.4 points ($p \leq 0.001$) was obtained. For ovariectomies performed by Lap-OVE, the score obtained was slightly lower, with a mean of 1.5 points (Table 3).

**Table 3.** Scores obtained with the subjective survey 1–5 point Likert scale*

| Survey questions | LESS-OVE | Lap-OVE |
|---|---|---|
| Difficulty of approach | 2.0 ± 0.7 | 2.0 ± 0.7 |
| Difficulty introducing port or device | 2.0 ± 0.7 | 1.8 ± 0.5 |
| Difficulty of surgical maneuvers | 2.4 ± 0.5 | 1.4 ± 0.5 |
| Difficulty in viewing anatomical structures | 2.0 | 1.6 ± 0.6 |
| Hemorrhage and control of hemostasis | 2.4 ± 0.5 | 1.4 ± 0.6 |
| Maneuverability and instrument collision | 3.4 ± 0.5 | 1.0 |
| Physical fatigue | 2.6 ± 0.5 | 1.6 ± 0.6 |
| Mental fatigue | 2.6 ± 0.5 | 1.6 ± 0.5 |
| (Mean ± SD) | 2.4 ± 0.6 | 1.5 ± 0.5 |

Degree of difficulty of the surgical approaches. *1 = none; 2 = low; 3 = moderate; 4 = high; 5 = very high.

## Discussion

This comparative study highlights the feasibility and therapeutic safety of LESS-OVE in dogs using a commercial single port device [3,30]. There were no significant differences in total surgical time, and LESS-OVE resulted in an acceptable surgical time, although it was slightly increased compared to Lap-OVE.

In this study, laparoscopic ovariectomy was selected as the technique of choice for female sterilization because it is a simple, less invasive and faster than ovariohysterectomy. Ovariectomy is preferred over ovariohysterectomy in healthy bitches without uterine abnormalities (mainly cystic endometrial hyperplasia - pyometra and uterine neoplasia) [16].

Minimally invasive surgery, particularly laparoscopic ovariectomy, has many advantages over traditional open surgery using either the LESS-OVE or Lap-OVE approach; namely, less postoperative pain, low morbidity, smaller incisions, better viewing of the ovarian pedicle, less risk of complications associated with surgical manipulation of the abdominal viscera, and faster recovery to normal activity [22]. These multiple advantages have encouraged many veterinarians to incorporate these surgical techniques into their daily surgical practice. However, there are few references available regarding the use of single portal access in veterinary laparoscopy, although some studies have described single incision laparoscopic ovariectomies using traditional laparoscopic portals [12,17]. Two recent studies described the use of a commercial single incision device with good results [21,31]. Single incision laparoscopic surgery represents an evolution of the laparoscopy as it further reduces the associated surgical trauma. However, it is challenging for the surgeon, as triangulation is limited, tending to restrict the range of motion and resulting in a potential conflict between instruments and scope, which in turn impairs ergonomics [5,29]. Previous studies have reported that a combination of articulated instruments increase the range of motion and triangulation, facilitating maneuverability in the surgical procedures [2]. Additionally, the use of a bipolar vessel sealer/divider device, which facilitates sealing and dividing the ovarian pedicle, has been shown to be feasible, safe and reduce surgical times in both the LESS-OVE and Lap-OVE approach

[7,25]. Another technical difficulty associated with this approach is less traction capability, resulting in worse surgical field exposure and poor bleeding control if inadvertent hemorrhage occurs [7]. Our experience confirms these findings and shows the need to develop more ergonomic and functional devices and instruments for this laparoscopic approach [28]. We strongly believe that the currently used single incision laparoscopy surgery is limited by technological development of LESS-specific instrumentation. Questionnaires provided by our surgeons revealed that LESS-OVE demands a high degree of technical knowledge and skill. In fact, the main limitations of laparoscopic surgery and other minimally invasive techniques are inadequate training and poor surgical experience [6]. For these reasons, we consider laparoscopic training programs, especially simulator-based ones, to be essential to overcoming the steep learning curve that has been demonstrated in human and veterinary surgery [11,14,20,33].

Most complications in laparoscopic surgery are related to abdominal cavity access and pneumoperitoneum establishment, hemorrhage, viscera perforation and tissue damage due to energy application [26]. These complications are frequent in the initial phases of the steep learning curve in laparoscopy, while they are less frequent in trained and experienced surgeons, such as those enrolled in our study. Moreover, use of the Veress needle might increase the risk of abdominal viscera damage [13]. Finally, it is important to note that, in this study the Veress needle was not used, and pneumoperitoneum was created using an open technique.

Limitations of this study include the small population size, the fact that the same surgeon performed all procedures and the lack of use of an objective postoperative pain scale. Thus, further studies should be conducted with a larger number of animals to obtain more representative data. This should be done using different surgeons from multiple institutions. Therefore, we strongly believe that it is essential to further evaluate this novel approach in clinical veterinary practice while providing a proper laparoscopic training program for veterinary surgeons, which will lead to benefits for patients.

In conclusion, LESS-OVE using a commercial single portal access device appears to be feasible and safe in healthy bitches. Although the total surgical time required for this technique is slightly greater than that of the traditional Lap-OVE method, it is still acceptable. During application of this technique, we observed a faster recovery in all cases and no postoperative complications associated with any approach. However, experienced surgeons still considered LESS-OVE to be a more skill-demanding technique.

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## Conflict of Interest

There is no conflict of interest.

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