







## ANAESTHETIC SPARING EFFECT OF LIDOCAINE DURING OVARIOHYSTERECTOMY IN BITCHES PREMEDICATED WITH REMIFENTANIL

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This prospective, randomized, blinded study evaluated the anaesthetic-sparing effect of topical lidocaine applied to the *mesovarium* during ovariohysterectomy in bitches premedicated with remifentanil. Twenty healthy female dogs undergoing elective ovariohysterectomy were randomly assigned to a lidocaine group (L, n = 10) or control group (C, n = 10). Anaesthesia was induced with propofol and maintained with sevoflurane. In the L group, 2% lidocaine (2 mg/kg) was applied as a splash block to the *mesovarium*, while saline was applied in the controls. End-tidal sevoflurane concentration (Fe'Sevo), heart rate (HR), respiratory rate ( $f_R$ ), invasive systolic and diastolic arterial blood pressure (IBPs, IBPd) and mean arterial pressure (MAP) were recorded at predefined time points. Fe'Sevo was down titrated in response to haemodynamic changes. Significant differences in Fe'Sevo were observed between groups, with lower concentrations required in the L group. Significant interactions between treatment and time were detected for HR, IBPd, MAP and  $f_R$ . The findings indicate that topical lidocaine reduces inhalation anaesthetic requirements and attenuates nociceptive responses during ovarian manipulation. The intraoperative use of lidocaine as part of multimodal analgesia may therefore provide clinical benefits in dogs undergoing ovariohysterectomy.

**Keywords:** analgesia; dog; lidocaine; remifentanil; local anaesthesia; ovariohysterectomy

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## INTRODUCTION

Ovariohysterectomy and gonadectomy are considered as the most frequently performed surgical techniques in small animal practice [1]. Despite its routine nature, ovariohysterectomy is a complex surgical intervention with possible short – and long-term surgical complications, and especially complications associated with moderate intra – and postoperative pain [2,3].

Ovariohysterectomy is performed under general anaesthesia, with inhalation anaesthetic agents as a method of choice, since this approach allows titration of anaesthetic depth [4]. Effective control of anaesthetic depth is sometimes difficult to achieve in practice and requires concentrations of the inhalational agent which often result in hypoventilation, hypotension and hypothermia [5]. The primary clinical indicators of inadequate anaesthetic depth and insufficient analgesic therapy are typically elevations in heart rate, respiratory rate, and arterial blood pressure [4,6,7].

Veterinary practitioners are becoming more aware of pain and its harmful effects in surgical patients. Studies support this motivation that sought to gain a deeper understanding of comparative anaesthetic and analgesic efficacy of the various drugs and techniques that can be used. They include individual drugs in their anaesthetic regime, use drug combinations and vary the dosages, route and timing of drug administration [5,8].

Perioperative analgesia has relied primarily on opioids and nonsteroidal anti-inflammatory drugs (NSAIDs). These agents are associated with significant adverse effects, such as prolonged recovery, dysphoria, respiratory depression, gastrointestinal ulceration, and renal and hepatic impairment, while their analgesic efficacy is sometimes limited when used alone [9,10].

Local anaesthetics represent a valuable component of multimodal and preemptive analgesic protocols. They are inexpensive, widely available, and demonstrate a significantly lower incidence of adverse effects compared to opioids. By completely blocking nociceptive transduction and transmission, local anaesthetics prevent central sensitization that would otherwise contribute to persistent postoperative pain [11]. This is especially important for older dogs, those with heart disease or other chronic conditions [5].

“Literature regarding the potential benefits of post-operative intraperitoneal local anaesthetic administration in dogs and cats remains sparse.” [12-16].

During ovariohysterectomy, both visceral and somatic nerves are stimulated, but it is not entirely clear which pain is dominant [13]. Identification, exposure and ligation of suspensory ligament and ovarian pedicle are considered to be the most painful phases of this surgical procedure [1,4]. The infiltration application of bupivacaine at the incision site [15] did not give satisfying results in pain management. Bubalo *et al.* (2008) applied local anaesthetic intraoperatively to the *mesovarium* and suspensory ligament, while anaesthetic depth was monitored by measuring changes in all vital parameters,

including invasive arterial blood pressure. The failure to demonstrate a statistically significant effect of the local anesthetic may be attributed to the confounding influence of methadone premedication, a long-acting opioid that potentially masked the efficacy of the local block [4].

This study evaluates the anesthetic-sparing effects of preoperative short-acting remifentanyl combined with intraoperative topical lidocaine application to the *mesovarium* and ovary during ovariectomy, specifically assessing their impact on perioperative vital parameters and the reduction of inhalant anesthetic requirements

## **MATERIALS AND METHODS**

Twenty healthy, client-owned female dogs were admitted for elective ovariohysterectomy at the Department of Surgery, Orthopedics and Ophthalmology at the Faculty of Veterinary Medicine, University of Belgrade, Serbia. The protocol, number of animals and methods used are comparable with the study of Bubalo et al. (2008). All dogs were of various breeds, 1-4 ( $2.95 \pm 0.48$  SD) years of age and 10-30 kg ( $16.75 \pm 3.8$  SD) of body weight. They were held in the same housing conditions (indoor/outdoor), and based on the anamnestic data obtained from the owner, a minimum of 3 months has passed since the last estrus cycle. Clinical examination was performed on each animal, and comprehended hematological and biochemical blood analyses, as well as examination of the genital tract (ultrasound, vaginal cytological smear and the electrical resistance of vaginal mucus – Draminski DOD2, Poland) with the aim of excluding estrus. This study was reviewed by the Ethics Committee of Ministry of Agriculture, Forestry and Water Management of Serbia; Veterinary Administration (No. 000449377 2025/4) and has been approved by the owners.

Dogs who were enrolled in the study were randomly divided into two groups, the treated group (L group, n= 10, Lidocaine – chloride 2%, Galenika, Belgrade, Serbia) and control placebo group (C group, n= 10, NaCl 0.9%, B. Braun Melsungen AG, Germany). The animals were fasted overnight, with free access to water. They were operated on the day of admission. Blood samples were obtained via cephalic venipuncture into vacutainers (with and without anticoagulant) and submitted within 30 minutes for hematological and biochemical analysis. All anaesthetic procedures and assessments were done by the same anaesthetist and surgery was done by the same surgeon.

Sedation was induced with midazolam 0.2 mg/kg IV (Dormicum, CHEPLAPHARM ARZNEIMITTEL GmbH, Germany) following the placement of an intravenous catheter in the cephalic vein. Continuous infusion of remifentanyl 0.2  $\mu$ g/kg/min (Remifentanyl B. Braun, HAMELN RDS S.R.O, Modra, Slovakia) was subsequently initiated until the first incision. General anaesthesia was induced with propofol 4-6 mg/kg IV (Propofol 1% Fresenius KABI GmbH, Graz, Austria) to effect, 15 minutes after sedation. After anaesthesia induction, tracheal intubation was performed with

an appropriate tube according to the size of the dog, and they were placed in dorsal recumbency and connected to an anaesthetic circle system. Anaesthesia was maintained with sevoflurane (Baxter Holding B.V., Utrecht, Netherlands) in oxygen ( $3\text{L minute}^{-1}$ ).

Throughout the procedure all dogs breathed spontaneously and received an infusion of  $10\text{ mL/kg/hr}$  of a balanced crystalloid solution (Hartman solution, Baxter S.A., Lessines, Belgium). After stable inhalational anaesthesia had been established with sevoflurane, the *A. metatarsalis dorsalis* was cannulated and connected to a previously calibrated pressure transducer. In the case where the dorsal metatarsal artery could not be cannulated, a central arterial catheter was placed in the femoral artery using the Seldinger method.

Clinical monitoring was performed using an anaesthetic monitor (Dräger vista 120, Drägerwerk AG & Co., Lübeck, Germany) that included monitoring of heart rate (HR), derived from the electrocardiogram; respiratory rate ( $f_R$ ), derived from the capnograph; invasive mean arterial blood pressure (MAP); invasive blood pressure systolic (IBPs); invasive blood pressure diastolic (IBPd); respiratory gas composition including inspiratory and expiratory concentrations of  $\text{O}_2$ ,  $\text{CO}_2$  and sevoflurane ( $\text{FE}'\text{Sevo}$ ); pulse oximetry and oxygen saturation and core body temperature using an esophageal probe. The values (HR,  $f_R$ , MAP, IBPs, IBPd and  $\text{FE}'\text{Sevo}$ ) were saved continuously in a digital format for offline analysis. Time points used for obtaining values of monitored parameters were T1 (after induction of anaesthesia before surgery), T2 (initial incision, celiotomy and localization of the ovaries) and T3 (manipulation of the ovarian ligament).

**Table 1.** Experimental design

	L group	C group
<b>No of animals</b>	10	10
<b>Time points</b>	T1 – after induction of anaesthesia, before surgery T2 – initial incision, celiotomy and localization of the ovaries T3 – manipulation of the ovarian ligament	
<b>Sampling</b>	Blood analyses – hematology and biochemistry	
<b>Monitored parameters</b>	ECG, HR, $\text{O}_2$ , $\text{CO}_2$ , $f_R$ , temperature, MAP, $\text{FE}'\text{Sevo}$	

**ECG** – electrocardiogram; **HR** – heart rate,  **$\text{O}_2$**  – oxygen saturation;  **$\text{CO}_2$**  – capnograph;  **$f_R$**  – respiratory rate; **MAP** – invasive mean arterial pressure;  **$\text{FE}'\text{Sevo}$**  – on end-tidal sevoflurane.

At the moment of the initial incision, the constant infusion of remifentanyl was discontinued. The surgical procedure began with an incision in the *linea alba* and celiotomy. In the L group, after accessing the right ovary with monitoring parameters at the basal level (heart rate, respiratory rate, arterial blood pressure, saturation) and sevoflurane at an endtidal concentration of 2.3% ( $\text{FE}'\text{Sevo}$ ), lidocaine was applied topically at a dose of  $2\text{ mg/kg}$  (Lidocaine – chloride 2%, Galenika, Belgrade, Serbia)

from a syringe with a needle to the ovary and *mesovarium*, and then after 5 minutes the same was repeated on the left ovary. The procedure on the right ovary consisted of stretching the ovarian ligament. If the monitoring parameters remained at the basal level, the sevoflurane concentration was reduced to 2.1%, for and maintained for 1 minute, and then the previous procedure of manipulating the ovarian ligament was repeated. The previous procedure was again repeated by reducing the sevoflurane concentration by 0.2% up to 1.5% or when the monitoring parameters increased by 20% compared to the basal level. In this case, a bolus of remifentanyl was administered and further manipulation was interrupted, and standard ligature placement and completion of the surgical intervention according to practice standards were performed. If the basal parameters did not increase by 20% during manipulation of the ovarian ligament of the right ovary, at a sevoflurane concentration of 1.5%, ligature placement and removal of the right ovary were performed. Then, with the sevoflurane concentration of 1.5% already achieved, manipulation of the ovarian ligament of the left ovary was performed, followed by the placement of ligatures and removal of the left ovary. The uterine body was ligated taking into account the position of the urethral opening, and then surgical sutures were placed in order to close the abdominal cavity, subcutaneous tissue and skin in the upper levels. In the C group of 10 dogs, instead of lidocaine, NaCl 0.9% saline was applied in an identical manner.

Postoperatively, the first dose of subcutaneous nonsteroidal anti-inflammatory therapy with Meloxidolor 0.1 mg/kg (Produlab Pharma B.V. Raamsdonksveer, The Netherlands) and antibiotic therapy with Synulox suspension, amoxicillin–clavulanic acid, 8.75 mg/kg, (HAUPT PHARMA LATINA S.R.L., Italy), was administered immediately before recovery from anaesthesia. A second dose was administered the following day during the control examination. Following discharge, oral treatment with Synulox tablets (HAUPT PHARMA LATINA 183 S.R.L., Italy, Latina, Borgo San Michele, Strada Statale) and Meloxoral oral suspension 0.15 mg/kg (Produlab Pharma B.V. Raamsdonksveer, The 185 Netherlands) was prescribed for continued antibiotic and analgesic therapy for 5 days.

### **Statistical analysis**

For all examined parameters except for the parameter FE'Sevo, one-way repeated measures analysis of variance and Tukey's honestly significant difference (HSD) test for a significance level of  $\alpha = 0.05$  were used for statistical analysis of data. Within repeated measures analysis of variance, the „Anaesthetic“ was the main effect (factor), while the „Time point“ represented the effect of repeated measures. For the parameter FE'Sevo, the one-way analysis of variance was used and Tukey's test based on its results. Statistical analysis was performed by statistical program package STATISTICA® v. 14.0 (TIBCO Software Inc., 2020).

## RESULTS

The mean duration of anaesthesia was  $127 \pm 15.4$  and  $108.4 \pm 11.3$  minutes and mean duration of surgery was  $60.3 \pm 12.6$  and  $45.4 \pm 8.4$  minutes for the L and C group, respectively. In our study, in 7 out of 20 animals, the central arterial catheter had been placed in the femoral artery using the Seldinger method.

Analysis of the variance of repeated measurements (Table 2) showed that the total mean values of monitored parameters (HR, IBPs, IBPd, MAP,  $f_R$ ) between the L group and the C group had no statistically significant differences except for the FE 'Sevo used.

**Table 2.** Results of repeated measures analysis of variance for the examined parameters

Effect	HR		IBPs		IBPd		MAP		$f_R$		Fe'Sevo				
	df	F	p	F	p	F	p	F	p	F	p	Effect	df	F	p
Anesthetic (A)	1	1.013	0.327	0.151	0.702	0.024	0.878	0.420	0.525	0.039	0.845	Anesthetic	1	64.960	0.000**
Error	18											Error	18		
Time point (T)	2	36.589	0.000**	3.949	0.028*	38.990	0.000**	32.845	0.000**	20.246	0.000**				
Interaction A×T	2	19.506	0.000**	1.332	0.277	13.703	0.000**	6.414	0.004**	5.014	0.012*				
Error	36														

1) – Labels for parameters of ANOVA: **df** – Degree of freedom, **F** – F value, **p** – p value (probability for F test)

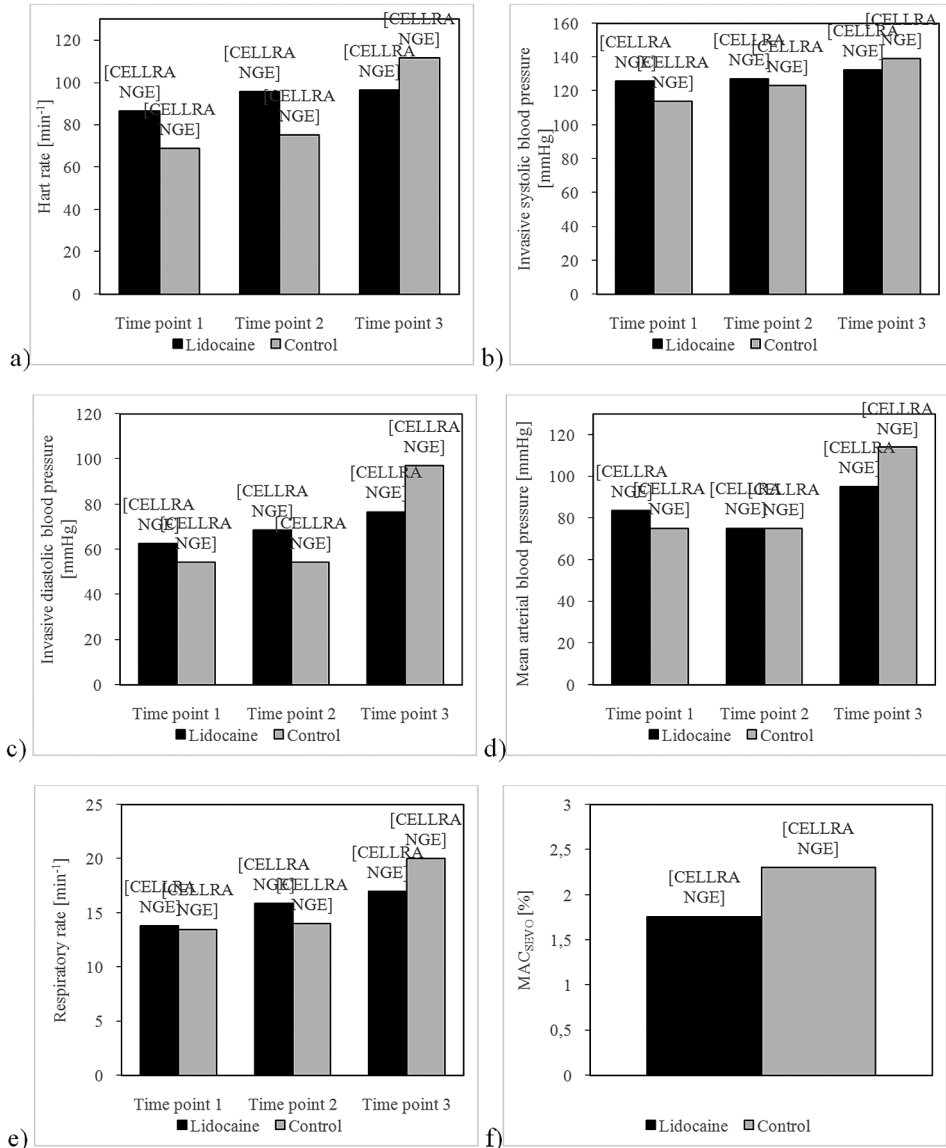
2) Labels for the F-test: \* –  $p < 0.05$ , \*\* –  $p < 0.01$

In the L group, there is no statistically significant difference in the response to noxious stimulation during the measurement through the time points (T1, T2, T3). However, there are statistically significant differences in the response of the patient to the treatment through the time points between the two experimental groups, statistically highly significant values ( $p < 0.001$ ) for all values except for IBPs where this value is significant for  $p < 0.05$ .

**Table 3.** Obtained results from Tukey's test for L and C group trough time points (T1, T2 and T3).

Variables	Group	Mean values for factor Anesthetic				Mean values for factor Time points		
		T1	T2	T3	Total	T1	T2	T3
<b>HR</b>	L	86.700abc	95.600ab	96.600ab	92.967a	77.750b	85.350b	14.150a
	C	68.800c	75.100bc	111.700a	85.200a			
<b>IBPs [mmHg]</b>	L	125.900ab	127.300ab	132.400ab	128.533a	119.950b	125.250ab	135.750a
	C	114.000b	123.200ab	139.100a	125.433a			
<b>IBPd [mmHg]</b>	L	62.500bc	68.700bc	76.700b	69.300a	58.400b	61.500b	86.850a
	C	54.300c	54.300c	97.000a	68.533a			
<b>MAP [mmHg]</b>	L	83.700bc	75.200bc	95.100ab	84.667a	75.100b	79.450b	104.550a
	C	75.200bc	75.000bc	114.000a	88.067a			
<b>f<sub>R</sub></b>	L	13.800b	15.900ab	17.000ab	15.567a	13.650b	14.950b	18.500a
	C	13.500b	14.000b	20.00a	15.833a			

**HR** – heart rate [ $\text{min}^{-1}$ ]; **IBPs** – invasive blood pressure systolic [mmHg]; **IBPd** – invasive blood pressure diastolic [mmHg]; **MAP** – mean arterial blood pressure [mmHg]; **f<sub>R</sub>** – respiratory rate [ $\text{min}^{-1}$ ].



**Figure 1.** Obtained results from Tukey’s test for the measured parameters in L and C group by time points: **a)** Heart rate; **b)** Invasive systolic blood pressure; **c)** Invasive diastolic blood pressure; **d)** Mean arterial blood pressure; **e)** Respiratory rate; **f)**  $\text{Fe}'\text{Sevo}$

The interaction Anaesthetic x Time points between experimental groups (Table 2), showed statistically very significant values ( $p < 0.001$ ) for HR, IBPd and MAP, while for  $f_R$  it was statistically significant ( $p < 0.05$ ).

Between the L and the C group, Tukey's test confirmed the absence of statistically significant differences using the mean values of the measured parameters, except for the FE'Sevo.

In the L group, one dog reached the FE'Sevo values of 1.5%, in 5 bitches the reached values were 1.7%, and rest of L group had values of 1.9% and 2.1%, equally.

Based on Tukey's test (Table 3), it was determined that the mean total values for the time points between the two experimental groups showed statistically significantly higher values in the T3 phase of the measurement than the previous measurements in the T1 and T2 points for all parameters except for IBPs and that between the T1 and T2 points. Tukey's test shows the trend of increasing values of the measured parameters with the measurement time in both groups.

The time dynamics of parameters shows clear differences between L and C group. After the application of lidocaine, the parameters did not change except for MAP for T1 and T2, while for all monitored parameters there is a statistically significant difference between the measured values at T3 and the other time points.

In the C group, there is a clear increase in the values of all measured parameters through the time points, which speaks in favor of the general trend of values growth of monitored parameters through T1, T2 and T3.

The treatment effect for the minimum used FE'Sevo concentration was significant according to the analysis of variance, and Tukey's test shows that lidocaine significantly reduced the use of the inhalational anaesthetic sevoflurane.

## **DISCUSSION**

During ovariohysterectomy, identification, exposure and ligation of the suspensory ligament and ovarian pedicle are considered to be the most painful phase [1,4,13].

To our best knowledge, there are only few studies regarding usage of lidocaine and his association with lower pain response during surgical procedures on reproductive tissue. These studies included mesovarium injection of lidocaine during standing laparoscopic ovariectomy in horses [17], intraperitoneal administration of lidocaine in humans [18-20], intratesticular application of lidocaine in pet rabbits [21] and in bitches [12,16,22,23]. The common for the above-mentioned studies is that they did not apply lidocaine during general anesthesia, usage of long-acting premedication, and a lack of statistical power of the study [4]

Bubalo et al. (2008) conducted a study that comprised 20 bitches subjected to ovariohysterectomy with the use of acepromazine and methadone as premedication, and the obtained results showed no evidence of an additional analgesic effect of infiltration of lidocaine in the mesovarium. The accepted method for demonstration of an analgesic effect of drug was changes of more than 20% in monitored

parameters (HR,  $f_R$ , MAP) during manipulation of the target tissue through surgery and consumption of isoflurane between two experimental groups.

In our study, although the obtained mean values of the monitored parameters for both experimental groups did not show statistical significance, there are significant differences between the monitored parameters throughout time points. This can be explained by delayed nociceptive response as a reaction to lidocaine exposure. Individual differences in the initial values of the monitored parameters are very pronounced, and for this reason there is equal diversity in the obtained values in both experimental groups, when the mean values in total are monitored.

Comparing the two experimental groups and the patients response to a nociceptive stimulus, there are statistically significant differences across time points for all measured parameters, as well as when measuring the interaction within lidocaine treatment and time points.

The study shows that there is a (nociceptive) reaction to the stimulus in both groups, but lidocaine application to the mesovarium by a splash block at the recommended dose led to the effect of an increased pain threshold. All values of the monitored parameters did not exceed 20% of the initial values until time point T3. The lidocaine effect was confirmed by Tukey's test for all parameters between T1 and T3 time points, which additionally confirms the hypothesis.

Cicirelli *et al.* (2022) aimed to demonstrate the efficacy of splash block using lidocaine during ovariectomy in bitches, and dexmedetomidine and methadone as premedication. The obtained results for heart rate, blood pressure and respiratory rate showed no significant differences between time points and experimental groups; for heart rate and blood pressure they found statistical differences among various time points. A recent study on 38 female bitches using lidocaine splash block during ovariohysterectomy [23], used dexmedetomidine and buprenorphine as a premedication. The overall heart rate and respiratory rate values in this study did not significantly differ between two groups ( $p=0.850$  and  $p=0.807$ , respectively), however, noninvasive mean arterial pressure significantly changed over time within each group during surgery ( $p < 0.001$ ), and additionally, differed between the two groups ( $p=0.002$ ). In our study, short-acting opioid (remifentanyl) and advanced monitoring parameters (such as invasive arterial blood pressure) give significant and reliable results between experimental groups and time points.

There are three steps that are questionable for the results obtained in the study of Bubalo *et al.* [4]: the dosage of lidocaine, the method of intraoperative lidocaine administration, and premedication with long-acting methadone. Bubalo *et al.* (2008) used 0.5mL of lidocaine (10mg) for each animal in the experimental group which was infiltrated via a syringe into the mesovarium, where additionally, the volume of lidocaine was limited by the size of the mesovarium. In our study, remifentanyl was used, characterized with very short-term analgesic effect between 2-5 minutes [24-26], compared to methadone which has a duration of analgesia in most patients between

8-10 hours [27-29], and during the manipulation of mesovarium and ligament, the effect of locally applied lidocaine could not be masked.

## CONCLUSION

The study demonstrates a clear difference in nociceptive response between the L and C group, highlighting the analgesic and clinical benefit of intraoperative usage of lidocaine on the mesovarium during ovariohysterectomy in bitches.

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### Authors' contributions

RD, LJS, VB and IWG designed and conceived the study, RD, LJS and SC selected the animals, carry out examinations and conducted the surgeries, draft the manuscript. VM and SC participated in material sampling and measurements, coordination of the experiment and helped to draft the manuscript. EV participated in the design of the study and performed the statistical analysis. All authors read and approved the final manuscript.

### Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

### Statement of Informed Consent


The owner understood procedure and agrees that results related to investigation or treatment of their companion animals, could be published in Scientific Journal *Acta Veterinaria-Beograd*.


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## REFERENCES

1. Van Goethem B, Schaefer-Okkens A, Kirpensteijn J: Making a rational choice between ovarioectomy and ovariohysterectomy in the dog: A discussion of the benefits of either technique. *Vet Surg* 2006, 35(2):136–143.
2. Devitt CM, Cox RE, Hailey JJ: Duration, complications, stress, and pain of open ovariohysterectomy versus a simple method of laparoscopic-assisted ovariohysterectomy in dogs. *J Am Vet Med Assoc* 2005, 227(6):921–927.
3. Zink C, Delgado MM, Stella JL: Vasectomy and ovary-sparing spay in dogs: Comparison of health and behavior outcomes with gonadectomized and sexually intact dogs. *J Am Vet Med Assoc* 2023, 261(3):366–374.
4. Bubalo V, Moens YP, Holzmann A, Coppens P: Anaesthetic sparing effect of local anaesthesia of the ovarian pedicle during ovariohysterectomy in dogs. *Vet Anaesth Analg* 2008, 35(6):537–542.
5. Mwangi WE, Mogoia EM, Mwangi JN, Mbutia PG, Mbugua SW: A systematic review of analgesia practices in dogs undergoing ovariohysterectomy. *Vet World* 2018, 11(12):1725.
6. Tsukamoto A, Serizawa K, Sato R, Yamazaki J, Inomata T: Vital signs monitoring during injectable and inhalant anesthesia in mice. *Exp Anim* 2015, 64(1):57–64.
7. Rivera DA, Buglione AE, Ray SE, Schaffer CB: MousePZT: A simple, reliable, low-cost device for vital sign monitoring and respiratory gating in mice under anesthesia. *PLoS One* 2024, 19(3): e0299047.
8. Goich M, Bascuñán A, Faúndez P, Siel D: Comparison of analgesic efficacy of tramadol, morphine and methadone in cats undergoing ovariohysterectomy. *J Feline Med Surg* 2024, 26(3):1098612X231224662.
9. Mathews DM, Cirullo PM, Struys MMRF, De Smet T, Malik RJ, Chang CL, Neuman GG: Feasibility study for the administration of remifentanyl based on the difference between response entropy and state entropy. *Br J Anaesth* 2007, 98:785–791.
10. Hellyer P, Rodan I, Burnt J, Rodan I, Brunt J, Downing, Hagedorn JE, Robertson: AAHA/AAFP pain management guidelines for dogs and cats. *J Feline Med Surg* 2007, 9(6):466–480.
11. Weinstein EJ, Levene JL, Cohen MS, Andreae DA, Chao JY, Johnson M, Hall CB, Andreae MH: Local anaesthetics and regional anaesthesia versus conventional analgesia for preventing persistent postoperative pain in adults and children. *Cochrane Database Syst Rev* 2018, 2018(6).
12. Carpenter RE, Wilson DV, Evans AT: Evaluation of intraperitoneal and incisional lidocaine or bupivacaine for analgesia following ovariohysterectomy in the dog. *Vet Anaesth Analg* 2004, 31:46–52.
13. Fitzpatrick CL, Weir HL, Monnet E: Effects of infiltration of the incision site with bupivacaine on postoperative pain and incisional healing in dogs undergoing ovariohysterectomy. *J Am Vet Med Assoc* 2010, 237:395–401.
14. Mathews K, Kronen PW, Lascelles D, Nolan A, Robertson S, Steagall PVM, Wright B, Yamashita K: Guidelines for recognition, assessment and treatment of pain: WSAVA Global Pain Council members and co-authors. *J Small Anim Pract* 2014, 55: E10–E68.
15. Benito J, Monteiro B, Lavoie AM, Beauchamp G, Lascelles BDX, Steagall PV: Analgesic efficacy of intraperitoneal administration of bupivacaine in cats. *J Feline Med Surg* 2016, 18(11):906–912.

16. Cicirelli V, Lacalandra GM, Aiudi GG: The effect of splash block on the need for analgesia in dogs subjected to video-assisted ovariectomy. *Vet Med Sci* 2022, 8:104–109.
17. Farstvedt EG, Hendrickson DA: Intraoperative pain responses following intraovarian versus mesovarian injection of lidocaine in mares undergoing laparoscopic ovariectomy. *J Am Vet Med Assoc* 2005, 227(4):593–596.
18. Ng A, Swami A, Smith G, Davidson AC, Emembolu J: The analgesic effects of intraperitoneal and incisional bupivacaine with epinephrine after total abdominal hysterectomy. *Anesth Analg* 2002, 95(1):158–162.
19. Shady N, Farouk H, Ali S, Abbas A: Effect of intraperitoneal and incisional port site lidocaine on pain relief after gynecological laparoscopic surgery: A randomized controlled study. *Middle East Fertil Soc J* 2017, 23.
20. Werawatakul Y, Sothornwit J, Laopaiboon M, Lumbiganon P, Kietpeerakool C: Interventions for intra-operative pain relief during postpartum mini-laparotomy tubal ligation. *Cochrane Database Syst Rev* 2019, 2:CD011807.
21. Serpieri M, Bonaffini G, Ottino C, Quaranta G, Mauthe von Degerfeld M: Effects of intratesticular lidocaine in pet rabbits undergoing orchietomy. *Animals* 2024, 14(4): 551.
22. Gomes VH, Peixoto AJ, Fernandes ME, de Souza Campos AC, Coelho CM, da Silva MF: Evaluation of lidocaine administration into the ovarian pedicle for the control of intraoperative and early postoperative pain during ovariohysterectomy in dogs. *Vet Anaesth Analg* 2024, 51(1):64–70.
23. Flouraki E, Loukopoulos E, Gougoulis D, Savvas I, Margeti C, Karagianni K, Tsioli V: The effect of lidocaine splash block followed by suspensory ligament massage in female dogs undergoing ovariohysterectomy: A prospective study. *Animals* 2024, 14(23):3522.
24. Michelsen LG, Hug Jr CC: The pharmacokinetics of remifentanil. *J Clin Anesth* 1996, 8(8):679–682.
25. Yu EHY, Tran DHD, Lam SW, Irwin MG: Remifentanil tolerance and hyperalgesia: short-term gain, long-term pain?. *Anaesthesia* 2016, 71(11):1347-1362.
26. Seddighi R, Geist A, Knych H, Sun X: The effect of remifentanil infusion on sevoflurane minimum alveolar concentration–no movement (MACNM) and bispectral index in dogs. *Vet Anaesth Analg* 2023, 50(2):121–128.
27. Ingvast-Larsson C, Holgersson A, Bondesson U, Lagerstedt AS, Olsson K: Clinical pharmacology of methadone in dogs. *Vet Anaesth Analg* 2010, 37(1):48–56.
28. Kreutzwiser D, Tawfic QA: Methadone for pain management: A pharmacotherapeutic review. *CNS Drugs* 2020, 34(8):827–839.
29. Amon T, Kästner SBR, Kietzmann M, Tümsmeyer J: Plasma levels of a methadone constant rate infusion and their corresponding effects on thermal and mechanical nociceptive thresholds in dogs. *BMC Vet Res* 2021, 17(1):35.

## ANESTIČKI “SPARING” EFEKAT LIDOKAINA TOKOM OVARIOHISTEREKTOMIJE KUJA PRETHODNO PREMEĐIKOVANIH REMIFENTANILOM

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Cilj studije je procena efikasnosti primene lokalnog anestetika lidokaina tokom ovariohisterektomije, primenjenog na mezovarijum, uz premedikaciju remifentaniom. Dvadeset zdravih ženki koje su podvrgnute elektivnoj ovariohisterektomiji nasumično su raspoređene u grupu s lidokainom (L, n = 10) i kontrolnu grupu (C, n = 10). Anestezija je indukovana propofolom i održavana sevofluranom. U L grupi, 2% lidokain (2 mg/kg) je aplikovan kao “splash blok” na mezovarijum, dok je u C grupi aplikovan fiziološki rastvor. Koncentracija sevoflurana na kraju izdisaja (Fe’Sevo), otkucaji srca (HR), brzina disanja ( $f_R$ ), invazivni sistolni i dijastolni arterijski krvni pritisak (IBPs, IBPd) i srednji arterijski pritisak (MAP) zabeleženi su u unapred određenim vremenskim tačkama. Fe’Sevo je titriran naniže kao odgovor na hemodinamske promene. Značajne razlike u Fe’Sevo uočene su između grupa, sa nižim potrebnim koncentracijama u L grupi. Značajne interakcije između tretmana i vremena otkrivene su za HR, IBPd, MAP i  $f_R$ . Ovi nalazi ukazuju na to da lokalni anestetik lidokain smanjuje potrebu za inhalacijskim anestetikom i ublažava nociceptivne odgovore tokom manipulacije jajnicima. Intraoperativna upotreba lidokaina kao dela multimodalne analgezije može pružiti kliničke koristi kod pasa koji se podvrgavaju ovariohisterektomiji.