

Epidural anesthesia with bupivacaine, bupivacaine and fentanyl, or bupivacaine and sufentanil during intravenous administration of propofol for ovariohysterectomy in dogs

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Objective—To compare cardiovascular and systemic effects and analgesia during the post-operative period of epidural anesthesia performed with bupivacaine alone or with fentanyl or sufentanil in bitches maintained at a light plane of anesthesia with continuous infusion of propofol.

Study Design—Prospective randomized masked clinical trial.

Animals—30 female dogs of various breeds.

Procedures—Dogs were allocated into 3 groups of 10 each. One group received fentanyl (2 µg/kg [0.91 µg/lb]) and bupivacaine (1 mg/kg [0.45 mg/lb]), 1 group received sufentanil (1 µg/kg) and bupivacaine (1 mg/kg), and 1 group received bupivacaine (1 mg/kg). All dogs received acepromazine (0.1 mg/kg [0.045 mg/lb]) and continuous infusion of propofol for sedation. The agents were administered into the lumbosacral space and diluted in saline (0.9% NaCl) solution to a total volume of 0.36 mL/kg (0.164 mL/lb). Cardiac and respiratory rates, arterial blood pressures, pH, and blood gases were evaluated. Analgesia, sedation level, serum cortisol concentrations, and plasma catecholamine concentrations were measured regularly for 6 hours.

Results—No important changes in cardiovascular, respiratory, or sedation variables were observed. Degree of analgesia in the postoperative period was higher in the sufentanil group, although use of fentanyl and bupivacaine also resulted in a sufficient level of analgesia.

Conclusions and Clinical Relevance—Use of the 3 anesthetic techniques permitted ovariohysterectomy with sufficient analgesia and acceptable neuroendocrine modulation of pain with minimal adverse effects. (*J Am Vet Med Assoc* 2007;230:45–51)

Epidural anesthesia is considered an extremely safe procedure. When it is adequately performed, it can be used efficiently for a wide variety of surgical procedures. Although epidural anesthesia is widely used in veterinary medicine, it is usually performed with local anesthetics and a vasoconstrictor, and when additional analgesia is required, morphine is the agent of choice. The use of opioids in the epidural space in humans can be associated with many adverse effects such as respiratory depression, excessive sedation, vomiting, urinary retention, and pruritis.¹ Nevertheless, because the combination of local anesthetics and opioids results in a synergistic effect, the dose and the dose-dependent effects of the agents can be reduced.^{2,3} Advantages of regional anesthetic techniques, compared with general anesthesia, include lower mortality and morbidity rates,⁴ no need for orotracheal intubation,⁵ better post-operative analgesia, and a decrease in surgical stress through the blockade of afferent nociceptive pathways and efferent sympathetic impulses to the pancreas and adrenal medulla.

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ABBREVIATIONS

VAS	Visual analogue scale
Sao ₂	Arterial oxyhemoglobin saturation

Benefits of sufentanil in relation to morphine include rapid effect and higher analgesic potency because of its high liposolubility, intermediate degree of ionization, low molecular weight, high affinity for μ receptors, and wide therapeutic margin.⁶ In humans, sufentanil reaches maximum plasma concentration 20 minutes after epidural administration, with minimal motor blockade.⁷ A good margin of safety is also observed in dogs when sufentanil is administered IV.⁸ Cohen et al⁹ determined that the necessary dose for sufentanil to induce analgesia is the same for epidural or IV administration.

Fentanyl is a pure μ -opioid agonist. As an analgesic, it is estimated to be 100 times as potent as morphine when administered IV but only 4 times as potent when administered intrathecally.¹⁰ The potency ratio of sufentanil versus fentanyl when administered into the epidural space is 5:1.¹¹ Epidurally administered morphine at a dose of 0.1 mg/kg (0.045 mg/lb) has an onset time of 20 to 60 minutes and duration of action of 16 to 24 hours.¹² Equipotent epidurally administered doses

of sufentanil and fentanyl in women undergoing labor have an onset time of 20 minutes and a duration of action of 2 to 3 hours.¹³

The low doses of sufentanil and fentanyl presently used in humans do not completely eliminate the possibility of respiratory depression. However, fentanyl and sufentanil are opioids that are highly liposoluble and migrate less than morphine in the intrathecal space. For this reason, late respiratory depression is less commonly observed after epidural administration.⁶

To our knowledge, the cardiovascular and analgesic effects of sufentanil and fentanyl have not been evaluated when administered by the epidural route in bitches undergoing ovariohysterectomy. Therefore, the purpose of the study reported here was to compare cardiovascular and systemic effects and analgesia during the postoperative period of epidural anesthesia performed with bupivacaine alone or with fentanyl or sufentanil in bitches maintained at a light plane of anesthesia with continuous infusion of propofol.

Materials and Methods

Animals—Thirty female dogs of different breeds and ages, admitted to the Surgery Department for ovariohysterectomy, were used in this study. History and physical examination were used to determine whether the dogs met the inclusion criteria of minimum weight of 6 kg (13.2 lb), systolic arterial pressure > 120 mm Hg as measured by use of the oscillometric method, normal results of neurologic examination, normal skin over the epidural injection site, and absence of known systemic diseases. The study was approved by the Bioethical Committee of the University of São Paulo, and owner's consent was obtained.

The dogs were randomly allocated into 3 groups of 10 each and were evaluated by the same observer who was unaware of group assignments. All dogs first received acepromazine^a (0.1 mg/kg, IM) as preanesthetic medication. Fifteen minutes later, a catheter was inserted into the cephalic vein for subsequent administration of propofol^b and lactated Ringer's solution at a rate of 10 mL/kg/h (4.5 mL/lb/h) during the surgical procedure. Clipping and surgical preparation were performed on the lumbar region before administration of the epidural agents. To facilitate the epidural injection, dogs received propofol (4 mg/kg [1.8 mg/lb], IV) to induce a light plane of anesthesia and were positioned in sternal recumbency. A 19-gauge Tuohy needle was inserted into the lumbosacral space, and proper positioning was confirmed by lack of resistance to injection of saline (0.9% NaCl) solution and subsequent ease of introduction of a 20-gauge epidural catheter^c up to the L5-6 intervertebral space. The position of the catheter was verified radiographically at the end of the surgery by injection of 0.8 mL of iohexol.^d Dogs in a group termed the fentanyl-bupivacaine group received fentanyl^e (2 µg/kg [0.91 µg/lb]) and 0.5% bupivacaine^f (1 mg/kg [0.45 mg/lb]), dogs in a group termed the sufentanil-bupivacaine group received sufentanil^g (1 µg/kg) and 0.5% bupivacaine (1 mg/kg), and dogs in a group termed the bupivacaine group received 0.5% bupivacaine (1 mg/kg). For all groups, the drugs were diluted in saline solution in a volume equivalent to 0.36 mL/kg

(0.164 mL/lb) and were administered during 1 minute; dogs were maintained in sternal recumbency for at least 15 minutes to facilitate the uniform spread of the drugs. Immediately before the beginning of the surgical procedure, a second dose of propofol (4 mg/kg, IV) was administered, followed by a continuous infusion of the same agent (0.2 mg/kg/min [0.09 mg/lb/min]) that was adjusted as necessary to maintain a light plane of anesthesia and the presence of reflexes. After propofol administration, dogs were positioned in dorsal recumbency. Cardiac and respiratory frequencies; systolic, diastolic, and mean arterial blood pressures measured by use of an oscillometric method with the appropriate-sized cuff placed at the metacarpus; and peripheral SaO_2 with the probe positioned in the vulva were evaluated by means of a multivariable analyzer^h at 3 times: time 0, before administration of propofol and the epidurally administered drugs; 30 minutes after epidural injection and at the beginning of the continuous infusion of propofol; and 60 minutes after epidural injection. All ovariohysterectomies were performed by the same surgeon by use of the 3-hemostats technique, beginning 30 minutes after the epidural injection. During surgery, the degree of abdominal relaxation (mild, moderate, or intense) was evaluated by the surgeon.

To evaluate the latency of motor blockade, pressure on an interdigital space of a hind foot was made with hemostats protected with rubber immediately after the epidural anesthesia and every 2 minutes until complete motor blockade was reached, which was detected when the dog could not retract its limb. To evaluate the onset time of sensory blockade, the same procedure was used. To differentiate the motor blockade from the sensory blockade, absence of painful sensation was verified by the absence of groaning, biting attempts, looking at the limb, and head shaking after the painful stimulus was performed with the hemostats. The spread of the blockade was evaluated via dermatomes by use of the panniculi test (pinching between the spinous process in the region of the vertebral column). To evaluate the duration of effect of the drugs, the same methodology used for evaluation of latency was used. This evaluation was performed every 15 minutes after completion of the surgical procedure.

Postoperative evaluation—Analgesia, sedation, heart rate, respiratory rate, and arterial blood pressure were measured postoperatively at 90, 120, 180, 240, 300, and 360 minutes after epidural injection. The degrees of analgesia and sedation were evaluated by use of the VAS, in which 0 corresponds to no pain or no sedation and 10 corresponds to dogs with the worst pain possible, and the scale proposed by the Colorado State University Veterinary Teaching Hospital,¹⁴ in which 0 corresponds to no pain and 25 to the worst pain possible. Rescue analgesia with morphineⁱ (0.1 mg/kg, IM) was planned for dogs with pain scores of 4 or higher for VAS or 10 or higher for the Colorado scale. Administration of morphine was to be repeated every 10 minutes until the score was lowered to an acceptable value. After the end of the study period, dogs received tramadol^j (2 mg/kg, PO) every 8 hours for 3 days and a single dose of carprofen^k (4.4 mg/kg [2 mg/lb], SC), followed by oral administration of an equal dose for 3 days.

pH and blood gases—Blood samples were collected at 0, 60, 120, and 360 minutes after the epidural injection via puncture of the femoral artery with a heparinized plastic syringe attached to a 25 × 8-mm needle covered with a rubber cap. Immediately after each collection, the samples were analyzed in a pH and blood gas analyzer^l for pH, PaO₂, PaCO₂ and SaO₂.

Serum cortisol and plasma catecholamine measurements—Samples for serum cortisol and plasma catecholamine analyses were collected at 0, 60, 120, and 360 minutes after epidural injection. To determine plasma catecholamine concentrations, jugular vein blood samples were collected in plastic syringes and transferred to glass tubes containing 100 µL of anti-coagulant (glutathione plus EDTA). Samples were immediately centrifuged in a freezing centrifuge^m for 10 minutes at 2,500 × g at 4°C. Blood samples were then transferred to 1.5-mL glass tubes and frozen at -80°C for later processing. Measurements of epinephrine and norepinephrine were performed via high-performance liquid chromatographyⁿ at the Clinical Laboratory of the Heart Institute of the University of São Paulo.

To determine serum cortisol concentration, jugular vein blood samples were collected through plastic syringes, transferred to glass tubes, and centrifuged at 1,500 × g for 10 minutes. Serum samples were frozen at -20°C for later processing by means of a fluoroimmunoassay.^o Measurements were made in duplicate in the Hormones Laboratory of the Clinics Hospital, School of Medicine, University of São Paulo.

Statistical analysis—To verify differences among groups, ANOVA was used with the assumption of gamma distribution¹⁵ of the observations of latency and duration of sensory and motor blockades. For catecholamines, ANOVA for repeated measures was used with the assumption of marginal gamma distribution.¹⁶ For the other measurements, ANOVA for repeated measures followed by the Bonferroni test¹⁷ for multiple comparisons was used to evaluate differences among time points within the same group and among groups. For all measurements, mean and SD values were determined. For all comparisons, *P* < 0.05 was considered significant.

Results

No significant differences were observed in age or weight of the dogs among the 3 groups. For latency of the motor blockade, the sufentanil-bupivacaine group had a significantly shorter time (4.2 ± 1.03 minutes), compared with the fentanyl-bupivacaine group (10.3 ± 10.53 minutes) and bupivacaine group (9.9 ± 10.79 minutes). For latency of the sensory blockade (28.5 ± 4.7 minutes, 21.3 ± 6.5 minutes, and 25.9 ± 3.7 minutes for the fentanyl-bupivacaine, sufentanil-bupivacaine, and bupivacaine groups, respectively), duration of the sensory blockade (206.1 ± 50.2 minutes, 239 ± 60.4 minutes, 205 ± 78.2 minutes for the fentanyl-bupivacaine, sufentanil-bupivacaine, and bupivacaine groups, respectively), duration of the motor blockade (200.6 ± 89.7 minutes, 251.5 ± 75.2 minutes, $229 \pm$

Table 1—Mean ± SD heart rate (HR [beats/min]) and respiratory rate (RR [breaths/min]) in dogs (n = 10/group) that received an epidural injection of fentanyl-bupivacaine, sufentanil-bupivacaine, or bupivacaine in association with propofol.

Time (min)	Fentanyl-bupivacaine group		Sufentanil-bupivacaine group		Bupivacaine group	
	HR	RR	HR	RR	HR	RR
0	124 ± 25	42 ± 18	117 ± 20	34 ± 13	124 ± 13	35 ± 11
30	101 ± 20*	20 ± 4*	119 ± 36	24 ± 10*	97 ± 12*	22 ± 8*
60	103 ± 19*	22 ± 6*	112 ± 35*	22 ± 7*	102 ± 20*	24 ± 7*
90	93 ± 13*	22 ± 6*	104 ± 32*	21 ± 5*	102 ± 19*	22 ± 3*
120	124 ± 27	24 ± 6*	118 ± 23	19 ± 6*	127 ± 35	24 ± 6*
180	121 ± 27	20 ± 5*	122 ± 24	23 ± 4*	133 ± 27	27 ± 6*
240	117 ± 24	22 ± 5*	118 ± 22	25 ± 2*	124 ± 24	27 ± 7*
300	113 ± 27	21 ± 3*	122 ± 20	24 ± 5*	120 ± 24	27 ± 7*
360	110 ± 19	22 ± 4*	108 ± 11	22 ± 6*	125 ± 19	26 ± 6*

*Significantly (*P* < 0.05) different from value at time 0.

Table 2—Mean ± SD systolic (SAP), mean (MAP), and diastolic (DAP) arterial pressures (mm Hg) in the same dogs as in Table 1.

Time (min)	Fentanyl-bupivacaine group			Sufentanil-bupivacaine group			Bupivacaine group		
	SAP	MAP	DAP	SAP	MAP	DAP	SAP	MAP	DAP
0	151 ± 19	110 ± 16	83 ± 16	139 ± 19	92 ± 14	66 ± 8*	145 ± 14	103 ± 17	77 ± 18
30	115 ± 18†	75 ± 10†	53 ± 15†	110 ± 23†	76 ± 19†	57 ± 19†	108 ± 21†	66 ± 16†	49 ± 12†
60	128 ± 23†	88 ± 19†	66 ± 26†	127 ± 30†	97 ± 28†	76 ± 23†	119 ± 26†	85 ± 23†	68 ± 20†
90	135 ± 25†	95 ± 20†	71 ± 16†	124 ± 21†	92 ± 23†	70 ± 19†	124 ± 16†	86 ± 22†	72 ± 21†
120	137 ± 18	103 ± 20	81 ± 25	128 ± 14	97 ± 16	76 ± 17	124 ± 19	98 ± 19	81 ± 20
180	143 ± 13	117 ± 9	97 ± 15	134 ± 27	106 ± 23	86 ± 18	127 ± 24	92 ± 23	74 ± 21
240	131 ± 16	99 ± 13	77 ± 19	121 ± 31	91 ± 30	73 ± 29*	137 ± 20	103 ± 22	85 ± 22
300	137 ± 19	108 ± 19	84 ± 16	121 ± 18	88 ± 20	72 ± 19*	136 ± 12	103 ± 22	83 ± 21
360	133 ± 19	107 ± 22	88 ± 25	134 ± 23	101 ± 23	77 ± 22*	150 ± 17	116 ± 16	91 ± 15

*Significantly (*P* < 0.05) different from values in other groups. †Significantly (*P* < 0.05) different from value at time point 0.

Table 3—Mean \pm SD blood gas variables in the same dogs as in Table 1.

Variable	Group	Time			
		0 min	60 min	120 min	360 min
Sao ₂	Fentanyl	97.06 \pm 1.06	95.62 \pm 2.83	97.30 \pm 1.2	96.8 \pm 1.15
	Sufentanil	95.84 \pm 1.56	95.40 \pm 2.76	96.53 \pm 2.4	96.75 \pm 0.86
	Bupivacaine	97.02 \pm 0.94	95 \pm 3.3	97.1 \pm 1.6	96.6 \pm 0.97
Paco ₂	Fentanyl	32.11 \pm 3.83	41.4 \pm 11.93*	35.8 \pm 7.27	30.63 \pm 3.81†
	Sufentanil	32.2 \pm 5.43	39.11 \pm 4.81*	36 \pm 4.09	30.55 \pm 3.18†
	Bupivacaine	31.18 \pm 2.84	35.38 \pm 5.76*	32.9 \pm 3.54	29.4 \pm 2.46†
pH	Fentanyl	7.36 \pm 0.06	7.26 \pm 0.08*	7.34 \pm 0.07	7.39 \pm 0.03
	Sufentanil	7.37 \pm 0.04	7.28 \pm 0.03*	7.34 \pm 0.03	7.39 \pm 0.02
	Bupivacaine	7.37 \pm 0.03	7.29 \pm 0.06*	7.35 \pm 0.03	7.39 \pm 0.02
HCO ₃ ⁻	Fentanyl	17.29 \pm 1.74	19.37 \pm 2.41	18.6 \pm 1.24	18.28 \pm 1.97
	Sufentanil	17.72 \pm 2.54	17.95 \pm 2.73	19.1 \pm 1.97	17.99 \pm 1.63
	Bupivacaine	17.35 \pm 1.83	18.73 \pm 2.45	18 \pm 1.76	17.30 \pm 1.70

*Significantly ($P < 0.05$) different from values at times 0, 120, and 360 minutes.
†Significantly ($P < 0.05$) different from value at 120 minutes.

Table 4—Mean \pm SD peripheral Sao₂ (%) in the same dogs as in Table 1.

Group	Time		
	30 min	60 min	90 min
Fentanyl	94.5 \pm 2.01	95.1 \pm 3.63	95.5 \pm 2.59
Sufentanil	93.9 \pm 2.60	95 \pm 2.67	95 \pm 2.87
Bupivacaine	95.2 \pm 2.74	95.3 \pm 2.95	95.6 \pm 2.32

75.7 minutes for the fentanyl-bupivacaine, sufentanil-bupivacaine, and bupivacaine groups, respectively), and anatomic extent of the blockade among the groups, there were no significant differences. For the fentanyl-bupivacaine group, the blockade reached from T10 to L2, for the sufentanil-bupivacaine group from T10 to L1, and for the bupivacaine group from T10 to L1.

All groups had similar changes in heart rate, respiratory rate, systolic and mean arterial pressures, arterial blood gas values, acid-base values, and Sao₂ (Tables 1–4). In the fentanyl-bupivacaine and bupivacaine groups, heart rates at 30, 60, and 90 minutes after epidural injection were significantly lower than control values (time 0), whereas in the sufentanil-bupivacaine group, the decrease in heart rate was significant only at 60 and 90 minutes after the epidural injection. Respiratory rate was decreased significantly at 30 to 360 minutes after epidural injection in all groups. Diastolic blood pressure was significantly lower in the sufentanil-bupivacaine group than the other groups at time 0 and at 240 to 360 minutes after epidural injection. In the fentanyl-bupivacaine and bupivacaine groups, all arterial blood pressures were significantly lower at 30 to 90 minutes, compared with values at time 0. In the sufentanil-bupivacaine group, systolic arterial pressure was similar to that of the other 2 groups; however, mean arterial pressure and diastolic arterial pressure were decreased significantly only at 30 minutes, compared with values at time 0. The pH was decreased significantly at 60 minutes, whereas Paco₂ was increased significantly at 60 minutes and decreased at 360 minutes. A high degree of abdominal relaxation was reported in all groups by the surgeon. Recovery after anesthesia was without complications for all dogs. There were no differences in the dose of propofol needed for each group (0.27

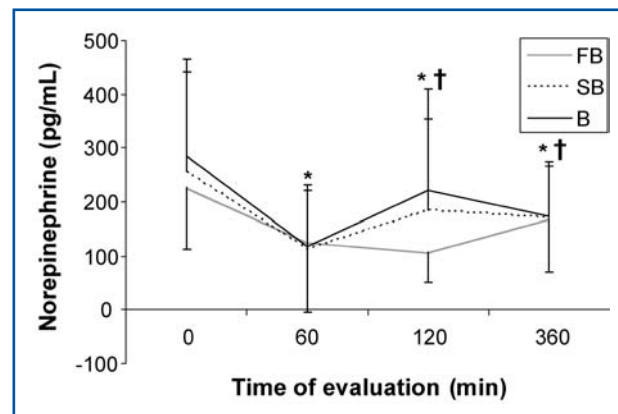


Figure 1—Mean \pm SD plasma norepinephrine concentrations in dogs ($n = 10$ /group) that received an epidural injection of fentanyl-bupivacaine (FB), sufentanil-bupivacaine (SB), or bupivacaine (B) in association with propofol. *Significantly ($P < 0.05$) different from value at time 0. †Significantly ($P < 0.05$) different from value at 60 minutes.

± 0.05 mg/kg/min [0.123 \pm 0.023 mg/lb/min], 0.29 \pm 0.06 mg/kg/min [0.13 \pm 0.027 mg/lb/min], and 0.28 \pm 0.08 mg/kg/min [0.132 \pm 0.027 mg/lb/min] for the fentanyl-bupivacaine, sufentanil-bupivacaine, and bupivacaine groups, respectively). Duration of surgery was 41 \pm 14.5 minutes, 39.0 \pm 14.2 minutes, 37.0 \pm 8.7 minutes for the fentanyl-bupivacaine, sufentanil-bupivacaine, and bupivacaine groups, respectively.

Plasma norepinephrine concentrations decreased significantly in all groups after epidural administration (Figure 1) and did not change for cortisol (time 0: 2.18 \pm 1.44, 1.72 \pm 1.07, and 1.34 \pm 0.97; 60 minutes: 2.85 \pm 1.38, 2.05 \pm 1.5, and 2.77 \pm 0.95; 120 minutes: 1.75 \pm 1.62, 2.05 \pm 1.72, and 2.35 \pm 1.55; and 360 minutes: 1.99 \pm 0.75, 1.87 \pm 1.5, and 2.06 \pm 0.97 for the fentanyl-bupivacaine, sufentanil-bupivacaine, and bupivacaine groups, respectively).

During the postoperative observation period in all groups, the VAS values did not vary significantly with time. However, the sufentanil-bupivacaine group had lower values, which were significantly different in relation to the bupivacaine group 360 minutes after epidural injection (Figure 2). For sedation values, according to

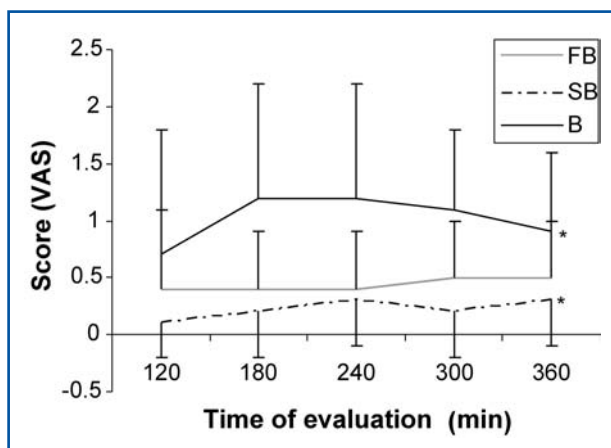


Figure 2—Mean \pm SD scores for pain assessment (VAS) in the same dogs as in Figure 1. *Values in the B group significantly ($P < 0.05$) different from values in the SB group. See Figure 1 for key.

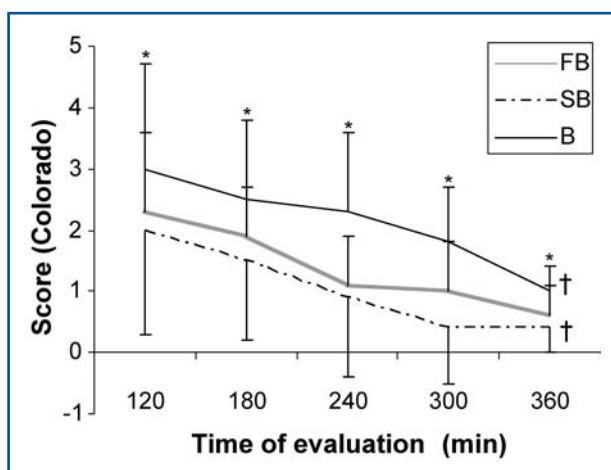


Figure 3—Mean \pm SD scores for postoperative pain and sedation assessment (Colorado State University Veterinary Teaching Hospital scale) in the same dogs as in Figure 1. *Significant ($P < 0.05$) differences among all time points. †Significant ($P < 0.05$) difference between the B and SB groups. See Figure 1 for key.

the same criteria (VAS values), a decrease in all groups was observed with time. For analgesia and sedation values, according to the Colorado scale, a decrease in all groups was observed during the postoperative period and the sufentanil-bupivacaine group had significantly lower values than those observed in the bupivacaine group 360 minutes after the epidural injection (Figure 3). In the bupivacaine group, scores of analgesia were significantly lower at 180 to 360 minutes after epidural injection than control values (time 0). No dogs in any group needed analgesic rescue medication during the postoperative period.

Discussion

The use of opioid analgesics, especially sufentanil, slightly enhanced the analgesia obtained through administration of bupivacaine. Use of bupivacaine alone in equal doses but with higher volume and dilution than that recommended in the literature (0.22 mL/kg [0.1 mL/lb])^{6,18} appeared quite adequate for the epidural anesthetic procedure.

Massone¹⁸ reported that epidural anesthesia, performed with local anesthetics and the volume commonly used, applied at the lumbosacral epidural space in bitches was not adequate for ovariohysterectomy because it does not result in desensitization of the ligamentum ovarii proprium. According to results obtained by Rocha,⁹ innervation of the ligamentum ovarii proprium depends on the afferent fibers from the first lumbar vertebra, which requires high volumes of anesthetic for desensitization. Nevertheless, in the present study, the concentration and dose of the applied drugs and the anatomic extent of the resultant nerve block made the surgical procedure possible by use of propofol in a dose sufficient only to induce a light plane of anesthesia.

Because of the dose and concentration of the drugs used in the present study, all dogs had adequate motor blockade. The shorter latency time of motor blockade observed in the sufentanil-bupivacaine group was attributable to sufentanil having rapid effect and high analgesic potency because of its high liposolubility, intermediate grade of ionization, and low molecular weight⁸; this results in quick passage through the dura mater, which is clinically reflected in a short latency period.¹⁹ It must be noted that the dose of sufentanil used here was 2.5 times the equipotent dose of fentanyl, which may have contributed to the observed results. Other authors²⁰ used different ratios, and the choice of this dose was based on our experience in pilot studies.

Latency of the sensory blockade in the present study was similar in all groups. Similar results were described by Braz et al.²¹ However, Johnson et al,²² who compared use of bupivacaine alone with use of bupivacaine and fentanyl in the epidural space of patients undergoing cesarean section, determined that use of the combined drugs reduced the time of latency of the sensory blockade by 35%.

Hypotension is an undesirable effect of epidural anesthesia and is caused by rostral spread of the local anesthetic with subsequent sympathetic blockade.²³ The degree of sympathetic blockade depends on the site of injection, dose of local anesthetic, and the preexisting state of the circulation.²⁴

In veterinary medicine, because the blockade is performed in the lumbosacral space of the animal, the occurrence of high sympathetic blockade is rare and transitory. In the present study, despite the fact that the blockade probably extended to the thoracic vertebrae, hypotension was not observed in any group. The dose of bupivacaine used and the technique applied (use of an epidural catheter and the slow velocity of injection) might have contributed to less sympathetic blockade. The sufentanil group had lower values of diastolic blood pressure, but values were within the reference range for dogs. Those data were in agreement with data reported by Futema,⁹ who used a combination of sufentanil and bupivacaine in bitches and did not detect hemodynamic alterations.

During surgery, values of pH decreased, whereas bicarbonate and Paco_2 increased in all 3 groups, suggesting mild respiratory depression. This may have been associated with infusion of propofol because when infusion was discontinued, those values returned to baseline. Weaver and Raptopoulos,²⁵ during anesthesia

with propofol, observed a reduction in ventilation and an increase in Paco_2 and suggested use of supplemental oxygen. Aguiar et al²⁶ observed dose-dependent respiratory depression represented by a decrease in respiratory rate, an increase in end-tidal CO_2 and Paco_2 , and a decrease in Pao_2 when they used a continuous infusion of propofol in dogs. Those observations also explain what occurred in the study reported here.

Comparison of the analgesic potency of these protocols was one of the aims of this study. For this reason, objective evaluations such as cortisol and catecholamine measurements as well as subjective evaluations such as the VAS scale and the descriptive scale were used. These methods have been well documented in human^{27,28} and veterinary literature.^{14,29,30} Dogs were evaluated by the same observer who was unaware of group assignments, which permitted unbiased evaluation of the analgesic effects of the drugs.³¹ To make comparisons possible and to validate the methods of the evaluation chosen here, the control group received only bupivacaine.

Dogs in the sufentanil-bupivacaine group had significantly lower scores of pain according to the VAS, compared with dogs in the bupivacaine group. Still, all dogs in the present study had low pain scores, and rescue medication was not needed. These results were similar to those observed by Rolfseng et al³² and Capogna et al,³³ who compared the analgesic potency of fentanyl and sufentanil combined with bupivacaine in women during parturition. The high liposolubility of sufentanil probably promotes rapid transfer through the blood-brain barrier, which increases its potency when administered parentally. When this agent is administered into the epidural space, close to the action site, its high liposolubility promotes high reabsorption, causing a decrease in its potency in relation to fentanyl when administered into the epidural space.³³

Opioids can cause sedation in the postoperative period and mask signs associated with pain and stress.¹⁹ For this reason, a sedation score was used in this study, which revealed that the high values obtained were mostly related to anesthetic recovery.

Single testing methods can result in erroneous findings. Thus, a combination of objective and subjective methods of evaluation is necessary for a more comprehensive and accurate analysis.³⁴ As objective indicators, cortisol and catecholamine concentrations were also measured, and they did not differ among the studied groups and were similar to the results obtained with regard to pain.

Epidural anesthesia, when applied skillfully, is a simple and safe procedure and, depending on the agents, doses, and volumes used, is adequate for various surgical procedures. In the present study, because a volume higher than that described in the literature was used,¹⁸ the blockade reached the first lumbar vertebra and the afferent fibers of the aortic plexus,^p which supplies the ovaries, oviducts, and uterus; this permitted ovariohysterectomy to be successfully performed. Additional studies are necessary to evaluate the applicability of the techniques used here and the use of lower doses, especially of bupivacaine, which could decrease the duration of motor blockade.

- a. Acepran, Univet, São Paulo, Brazil.
- b. Diprivan, AstraZeneca International, London, UK.
- c. 20-gauge epidural catheter, BD, São Paulo, Brazil.
- d. Ominipaque, Sanofi-Synthelabo, Shanghai, China.
- e. Fentanil, Jansen Farmacêutica, São Paulo, Brazil.
- f. Neocaína, Cristália, São Paulo, Brazil.
- g. Fastffen, Cristália, São Paulo, Brazil.
- h. Viridia 685, Hamlett Packard, Boeblingen, Germany.
- i. Dimorf, Cristália, São Paulo, Brazil.
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