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EPIDURAL ANAESTHESIA FOR CASTRATION OF THE BITCH

B. AMINKOV & N. ZLATEVA

Faculty of Veterinary Medicine, University of Forestry, Sofia, Bulgaria

Summary

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The aim of the present study was to evaluate the efficacy of three epidural anaesthetic protocols for ovariohisterectomy of bitches.

In 3 groups with 40 patients each, the following epidural anaesthetic combinations were applied: 1. xylazine 0.25 mg/kg of 2% injectable solution and fentanyl citrate 0.1 mg/kg diluted in sodium chloride solution up to 0.3 mL/kg (EA–XF); 2. lidocaine hydrochloride 2% injectable solution 0.3 mL/kg and xylazine 0.25 mg/kg of 2% injectable solution (EA–XL); 3. medetomidine hydrochloride 0.015 mg/kg and fentanyl citrate 0.005 mg/kg diluted with 0.3 mL/kg sodium chloride solution (EA–FM).

Statistically significant changes in respiratory rate were observed in the EA–XF group between min 10 and 60, in the EA–XL group by min 30, 40, 50 and 60 and in the EA–FM group between min 30–60 ($p<0.05$; $p<0.01$). The changes in heart rate were statistically significant in the EA–XF group by min 40, 50 and 60 ($p<0.01$), in EA-XL dogs by min 50 and 60 ($p<0.05$) and in the EA–FM group by min 50 and 60 ($p<0.01$). The best muscle relaxation was observed in EA–XL dogs.

The results showed that all three epidural anaesthetic protocols provided an excellent analgesia during and after the castration of bitches.

Key words: bitches, epidural anaesthesia, fentanyl, lidocaine, medetomidine, ovariohysterectomy, xylazine

INTRODUCTION

The effective antinociception during and following surgery is of primary importance for the attenuation of stress response and the full recovery of the patient.

In veterinary practice, the intravenous and inhalational anaesthesia are the commonest methods for intra- and postoperative analgesia. The perioperative alleviation of pain is entirely dependent on analgesic properties of premedication drugs and intravenous and inhalational agents, used for premedication and maintainance. Generally, these methods provide a minimal postoperative analgesia.

The epidural administration of local anaesthetic drugs with opioids (Akerman *et al.*, 1988; Maves and Gebhart, 1992; Yao *et al.*, 2002; Troncy *et al.*, 2002; Katz *et al.*, 2003) and alpha$_2$-adrenergic agonists (Beder *et al.*, 1986; Mensik *et al.*, 1987; Nishikawa and Dohi, 1990) provide an excelent intra- and postoperative analgesia. Nevetheless, more information about the precise application of anaesthetic protocols for performance of given surgical intervention in the different animal species is still needed.

The aim of this work was to study the appropriateness of epidurally administered xylazine/fentanyl, lidocaine/xylazine and medetomidine/fentanyl combinations in castration of bitches.

MATERIALS AND METHODS

Animals

The studies were performed on 120 mixed-breed bitches at a various age and body weight of 8–30 kg. Prior to the operation, the animals fasted for 24 h and were allowed a free access to water.

Operative technique

Experiments were conducted at the Small Animal Clinic – Surgery and Radiology Ward, Faculty of Veterinary Medicine, University of Forestry – Sofia.

The epidural anaesthesia was performed with spinal needles with a stylet and a syringe containing the calculated dose of an analgesic agent. The needle's gauge depended on the size of the patient. For small dogs – 22 gauge, 3.8 cm spinal needles; for middle-size dogs – 20 gauge, 3.8 cm spinal needles and for large and giant dogs – 20 gauge, 6.35 cm were necessary.

The area above the epidural space was shaved and aseptically prepared with povidone-iodine or chlorhexidine. The epidural anaesthesia was done aseptically. The lumbosacral interspace was identified through iliac crests and the processes of last lumbar (L7) and the first sacral (S1) vertebra. It was palpated in both directions (cranially and caudally) moving the fingers over the spinous processes of L6-L7 and S1-S2. The L7–S1 interspace was identified with the thumb and the middle finger of one hand placed over the most prominent part of the iliac crest and a forefinger directed towards the tail. Moving the forefinger cranially helped to identify the lumbosacral interspace. The spinal needle was inserted perpendicularly to the skin in the deepest place (in the middle between L7 and S1) between both spinous processes. The proper position of the needle was identified by the following criteria: the lack of resistance after piercing the skin, an increased resistance when piercing the ligamentum flavum, a "pop" sound and a loss of resistance when the ligament was pierced. Then the introduction of the needle was discontinued, the stylet was removed and the presence of blood or cerebrospinal fluid was verified via conenction of the needle to a syringe and creation of a vacuum in order to absorb the cerebrospiinal fluid (if present). When blood was present, the needle was removed and the whole procedure was repeated.

The epidural space was identified by injection of 2–3 mL of air. If the air injection occurred without resistance, the needle was within the epidural space. Otherwise, a crepitation was felt during palpation of the skin around the needle.

Anaesthetics

The following anaesthetic agents were injected in the epidural space:

- Combination of xylazine (Rompun 2% injectable solution, Bayer, Germany) 0.25 mg/kg and fentanyl citrate (Fentanyl, Gideon-Richter, Hungary) 0.1 mg/kg, diluted in sodium chloride solution up to 0.3 mL/kg (EA–XF);
- Combination of lidocaine hydrochloride 2% injectable solution (Lidocain, Sopharma, Bulgaria) 0.3 mL/kg and xylazine 0.25 mg/kg (EA–XL);
- Combination of medetomidine medetomidine hydrochloride (Domitor, Farmos Group, Finland) 0.015 mg/kg

and fentanyl citrate 0.005 mg/kg, diluted with 0.3 mL/kg sodium chloride solution (EA–FM).

Each combination was applied to 40 dogs.

Parameters monitored

Prior to and during the surgical intervention, the following parameters were monitored: heart and respiratory rates, abdominal muscle relaxation and pulling of the mesovarium out of the abdominal cavity (during the operation). The heart rate was followed out on a cardiomonitor (Medical Systems Co., Greenvate, NY) and the respiratory rate – by the movements of the thorax. The operation lasted between 40–50 min. When the mesovarium was pulled and the three forcepses were put on, the changes in both heart and respiratory rates were followed out, as well as the reaction of the patient (expressed in raising of the head, movements with the forelimbs and whining).

The analgesic effect of epidurally administered combinations was evaluating using a simple scoring system based on behaviour assessment as followed: score 4 = no discomfort ; score 3 = exhibiting a slight discomfort; score 2 = painful, disturbed; score 1 = painful, crying and score 0 = spontaneoulsy crying, stupor or hyperaesthesia. The survey of patients was done hourly up to post operative hour 6.

The data for respiratory and heart rates in 10 representative dogs with any of anaesthetic protocols were statistically processed using one-way analysis of variance vs baseline values.

RESULTS

It was determined that all three methods provided a very good intra- and postoperative analgesia. During the surgical intervention and when the mesovarium was pulled and ligated (the moment of the most painful stimulus), no increase in heart and respiratory rates, turning and rising of the head or whineing were observed. At the end of the operation, the application of all three epidural combinations resulted in a gradual decrease of heart and respiratory rates. Statistically

Table 1. Changes in respiratory rate (RR) and heart rate (HR) following epidural administration of xylazine/fentanyl (EA–XF); xylazine/lidocaine (EA–XL) and fentanyl/medetomidine (EA–FM) in dogs. Data are presented as mean ± SD

Group		EA-XF		EA-XL		EA-FM	
Variable		RR, min^{-1}	HR, min^{-1}	RR, min^{-1}	HR, min^{-1}	RR, min^{-1}	HR, min^{-1}
Time after treatment (min)	0	28±4	100±15	24±7	100±17	23±7	117±22
	10	19±6**	101±12	21±7	106±23	20±5	112±19
	20	16±5**	94±6	18±5	96±22	17±4*	109±24
	30	16±6**	84±11*	16±5*	90±24	16±4**	93±32
	40	15±5**	77±16**	15±5**	80±15	14±3**	97±22
	50	14±6**	74±13**	15±5**	81±16*	13±2**	86±21*
	60	15±5**	75±14**	17±5*	81±15*	14±3**	84±18**

* $p<0.05$; ** $p<0.01$ vs baseline.

significant changes in respiratory rate were observed in the EA–XF group between min 10 and 60 ($p<0.01$), in the EA–XL group by min 30, 40, 50 and 60 ($p<0.05$; $p<0.01$) and in the EA–FM group between min 20–60 ($p<0.05$; $p<0.01$) (Table 1). The changes in heart rate in EA–XF were statistically significant by min 30, 40, 50 and 60 ($p<0.05$; $p<0.01$), in EA–XL by min 50 and 60 ($p<0.05$) and in EA–FM – by min 50 and 60 ($p<0.05$; $p<0.01$). The best muscle relaxation was observed in EA–XL group. Immediately after the end of the operation, EA–FM dogs got up and were able to move without help.

DISCUSSION

The results of the present study demonstrated that the epidural co-administration of lidocaine with xylazine, xylazine with fentanyl and fentanyl with medetomidine produced an effective and safe analgesia during the sugical intervention. All three epidural combinations resulted in a good postoperative analgesia within the studied period. Our results support the hypothesis that the effects of fentanyl, xylazine, medetomidine and lidocaine epidurally administered in combinations prior to a surgical intervention interrupt the transmission of noxious stimuli towards the spinal cord and thus, prevent the development of sensibilization or hyperexcitability of neurones in its dorsal horns (Coderre *et al.*, 1993). The application of morphine or bupivacaine and morphine (Troncy *et al.*, 2002), oxymorphone or medetomidine (Cribb, 1993) in dogs produces a postoperative analgesia for 19.6 h, 7.62±0.3 h and 7.06±0.5 h respectively.

It is known that epidurally or spinally administered opioids provide a long postoperative analgesia, but can not block completely the intraoperative pain. Their efficacy increases when given before the onset of the pain (Yaksh, 1979; Puke, 1993). Co-administered narcotics and local anaesthetics produce synergetic interaction (Besson and Chaouch, 1987; Badenr *et al.*, 1991). Opioids and local anaesthetics possess different sites and modes of action. The primary mechanism of action of local anaesthetics is sodium channel blockade and axon conduction blockade. The antinociceptive effect of opioids is mediated by their interaction with specific receptors (Yaksh, 1981). The local anaesthetics probably induce also conformational change in the spinal opioid receptors (Tejwani *et al.*, 1992). On the other hand, their co-administration may cause changes in the pharmacokinetics of each agent (Badner *et al.*, 1991; Penning and Yaksh, 1992). Lipid soluble opioid derivatives as fentanyl and sufentanyl are most commonly combined with local anaesthetics. When administered epidurally, they are rapidly absorbed into the systemic circulation and exert their effects via a spinal and a supraspinal mechanism.

Co-administration of alpha$_2$-adrenergic agonists and local anaesthetics provide prolonged analgesia in humans (Ralcle *et al.*, 1987; Nishikawa and Dohi, 1990) and dogs (Bedder *et al.*, 1986; Mensink *et al.,* 1987). The mechanism of that prolongation is not known. Local vasoconstriction by α_2-receptor agonists has been suggested as a cause, but it is unlikely because analgesia could not be abolished by vasodilators (Reddy *et al.*, 1989). However, the alpha$_2$–adrenergic agonists can inhibit the vasodilatative propertities of local anaesthetics and delay the subsequent vascular uptake (Ralcle *et al.*, 1987; Mensink, 1987). Xylazine may extend the sensor blockade of lidocaine through presynaptic alpha$_2$-adrenoceptor mechanism, postsynaptic alpha$_2$-adrenoceptor mechanism and alpha$_2$-adrenoceptor arteriolar effect (Bedder *et al.*, 1986).

The epidural administration of a combination of opioids and alpha$_2$-adrenergic agonists could result in an additive or potentiated interaction which is strongly dependent on the proportion of the doses used. The epidural administration of a combination of fentanyl and medetomidine in rats produce a potentiated effect only when the ratio of medetomidine and fentanyl is 3:1 (Omote *et al.*, 1991).

The analgesic effect of medetomidine and fentanyl within the spinal cord results from the effects induced via two completely different, but interrelated mechanisms. Alpha$_2$-adrenergic agonists mimic the effect of descending antinociceptive fibers originating in the spinal cord (Yaksh, 1979; Besson and Chaouch, 1985; 1987). These fibers utilize norepinephrine as a terminal neurotransmiter, thus providing a potential binding site for the alpha$_2$-adrenergic agonists (Yaksh, 1981; Besson and Chaouch, 1987; Ossipov, 1990). This antinociceptive mechanism results in inhibition of the rostral transmission of nociceptive impulses at synapses between peripheral fibers and ascending fibers in the dorsal horns by hyperpolarization of presynaptic membranes and inhibition of neurotransmiter release (Yaksh *et al.*, 1980; Besson and Chaouch, 1978; Ossipov, 1990) as well as via postsynaptic inhibition of rostral transmission (Hylden and Wilcox, 1983).

Exogenous opioids exert their effect on opioid receptors located in the dorsal horns by blocking the nociceptive transmission and produce hyperpolarization of the afferent fiber terminals by inhibiting neurotransmitter release (Besson and Chaouch, 1987). This could be due to opioids binding to presynaptic receptors of the afferent terminals themselves or by the effect of interneurons using norepinephrine as a terminal neurotransmitter (Besson and Chaouch, 1987). Alternatively, opioids could bind to postsynaptic sites to inhibit rostral nociceptive transmission by neurons originating in dorsal horns (Hylden and Wilcox, 1983).

Both μ and δ receptors are involved in opioid-induced spinal level analgesia (Hylden and Wilcox, 1983). However, the synergetic response, seen when opiates and alpha$_2$-adrenergic agonists are co-administered, may require δ opioid receptors activation (Hylden and Wilcox, 1983; 1991). The observed interactions between alpha$_2$-adrenergic agonists and opioids are probably dependent on used agents, their doses and route of administration.

The results of the present experiments indicate that the epidural co-administration of lidocaine/xylazine; lidocaine/fentanyl and medetomidine/fentanyl combinations produce a good intra- and post-operative analgesia and a good muscle relaxation. The combination of different drugs allows the use of lower doses of each drug thus decreasing the potential undesirable side reactions.

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Correspondence:

Assoc. Prof. B. Aminkov,
Faculty of Veterinary Medicine,
University of Forestry,
1756 Sofia, Bulgaria