

Electroanalgesia for the postoperative control pain in dogs

Eletranalgesia para o controle da dor pós-operatória em cães

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ABSTRACT

PURPOSE: To evaluate the analgesic and neuroendocrine effects of electroanalgesia in dogs undergoing ovariohysterectomy.

METHODS: Eighteen dogs were randomly distributed to three groups of six animals each and received either electrical stimuli at acupuncture points (EA), at peri-incisional dermatomes (DER) and at both acupuncture points and peri-incisional dermatomes (EAD). Pre-anesthetic medication was acepromazine (0.05mg kg⁻¹, IV). Anesthesia was induced with propofol (4 to 5mg kg⁻¹, IV) and maintained with isoflurane. Postoperatively pain degree was measured using a numerical rating scale. Dogs were scored at 1, 3, 6, 12 and 24 hours postoperative. If the pain score was ≥ 6 , supplemental morphine (0.5mg kg⁻¹, IM) was administered. Serum cortisol concentration was measured before pre-anesthetic medication (basal), and at 1, 12 and 24 hours postoperative.

RESULTS: EA and EAD- treated dogs had lower pain scores than DER treated dogs one hour postoperatively. Fewer EA and EAD-treated dogs required rescue analgesia. Serum cortisol did not differ among treatments.

CONCLUSION: Preoperative application of electrical stimuli to acupuncture points isolated or in combination with peri-incisional dermatomes provides a reduced postoperative opioid requirement and promotes an effective analgesia in dogs undergoing ovariohysterectomy.

Key words: Electroacupuncture. Analgesia. Ovary. Hysterectomy. Salpingectomy. Dogs.

RESUMO

OBJETIVO: Avaliar os efeitos analgésicos e neuroendócrinos da eletranalgesia em cadelas encaminhadas para ovariossalpingohisterectomia.

MÉTODOS: Foram avaliadas 18 cadelas, distribuídas aleatoriamente em três tratamentos de seis animais cada: aplicação de estímulo elétrico em pontos de acupuntura (EA), em dermatômos periincisionais (DER) e em pontos de acupuntura associados aos dermatômos periincisionais (EAD). Todos os animais foram tranquilizados com acepromazina (0,05mg kg⁻¹, IV), seguindo-se a indução com propofol (4 a 5mg kg⁻¹, IV) e manutenção anestésica com isofluorano. O grau de analgesia foi avaliado 1, 3, 6, 12 e 24 horas após a cirurgia mediante escala descritiva numérica. Animais com escores ≥ 6 receberam analgesia de resgate com morfina (0,5mg kg⁻¹, IM). A concentração sérica de cortisol foi avaliada antes da tranquilização, 1, 12 e 24 horas após a cirurgia.

RESULTADOS: Escores inferiores de dor foram observados nos tratamentos EA e EAD em relação ao DER na primeira hora pós-operatória. A analgesia de resgate foi menos requerida nos animais dos tratamentos EA e EAD. O cortisol não diferiu entre os tratamentos.

CONCLUSÃO: A eletroestimulação de acupontos isolados ou associados aos dermatômos periincisionais reduz o requerimento pós-operatório de opioides, bem como confere efetiva analgesia para cadelas submetidas à ovariossalpingohisterectomia.

Descritores: Eletroacupuntura, Analgesia. Ovario. Histerectomia. Salpingectomia. Cães.

Introduction

The use of electrical stimulation for pain control began many centuries ago. However, interest in electroanalgesia increased after pain physiology was better understood, as well as to the efforts of researchers interested in finding alternatives to the traditional opiate and non-opiate analgesic drugs¹.

Several studies have shown that patients receiving electrical stimulation applied at the traditional Chinese acupoints (electroacupuncture) prior to surgery have a lower level of pain, reduced opioid requirement, a lower incidence of post-nausea and vomiting, and lower sympatho-adrenal responses²⁻⁶. In addition, other studies have demonstrated that the electrical stimulation applied at the dermatomal levels corresponding to the skin incision also reduces pain and postoperative opioide analgesic requirement^{7,8}. However, better results have been published when the electrical stimulation was applied simultaneously at both the dermatome corresponding to the surgical incision and a classical Chinese acupoint⁹.

The purpose of this study was to evaluate the analgesic and neuroendocrine effects of electroacupuncture, electrical stimulation at the peri-incisional dermatomes and electroacupuncture plus electrical stimulation at the peri-incisional dermatomes in dogs undergoing ovariohysterectomy.

Methods

This study was approved by the Institutional Animal Research Ethical Committee (protocol number 107/06), and permission for participation of each dog was obtained from the owner. Eighteen healthy adult, crossbreed, female dogs, weighing 4.5 to 26 kg (11 ± 12 kg) were evaluated. The animals indicated for elective ovariohysterectomy were selected by physical examination and laboratorial tests (complete blood cell count, serum biochemistry).

After withdrawal of food and water for 12 and 3 hours, respectively, the animals underwent the same anesthesia protocol. All dogs were sedated with acepromazine (0.05 mg kg^{-1}) administered intravenously (IV). Fifteen minutes after sedation, the dogs were randomly and equally distributed into three treatments: EA ($n=6$) - The needles were introduced bilaterally into ST 36, SP 6 and GB 34 acupoints. An alternating square wave dense/disperse 0.2ms continuous electrical stimulus was used (3 - 200 Hz). EA (Sikuro, DS100, Brazil) started with zero current and increased slowly until local muscle contractions were observed. DER ($n=6$) - similar to the treatment described for EA, but with electrical

stimulation applied at the dermatomal levels corresponding to the abdominal incision. The acupuncture needles were inserted longitudinally, covering a 4cm-area on both the right and left sides of the surgical incision, which was performed over the linea alba, under the umbilical scar. The same stimulus used in EA was applied, with the same duration. EAD ($n=6$) - the electrical stimuli were applied at the acupoints as described for EA treatment group, and at the dermatomal level as described for DER treatment group.

The electrical stimulation was applied for 45 minutes before induction of anesthesia. After that, anesthesia was induced with propofol (4 to 5 mg kg^{-1} , IV). The trachea was intubated and anesthesia maintained with isoflurane under spontaneous ventilation using a partial rebreathing system with an oxygen flow of $1 \text{ L}^{-1} \text{ min}^{-1}$. Ringer's solution ($10 \text{ mL kg}^{-1} \text{ h}^{-1}$) was infused intravenously by peristaltic infusion pump throughout the surgical procedure. All animals underwent routine ovariohysterectomy through a 2 to 3 cm midline incision by the same experienced surgeon.

During the first 24 hours postoperative, the animals underwent a blind evaluation of the analgesia degree using a numerical pain scale¹⁰⁻¹², with postoperative measurements at 1, 3, 6, 12 and 24 hours postoperative. Pain scores were assigned, and the maximum possible scores obtained was 20 (Table 1). Scores of 0 to 5 indicated mild pain, scores of 6 to 9 indicated moderate pain, and scores of more than 10 indicated severe pain. Additional analgesia was given (intramuscular morphine at 0.5 mg kg^{-1}) to dogs that scored 6 or more.

TABLE 1 - Numerical pain scoring system applied to dogs after ovariohysterectomy.

Observation	Criteria	Score
Heart rate	<= 10% above preoperative value	0
	11% - 30% above preoperative value	1
	31% - 50% above preoperative value	2
	> 50% above preoperative value	3
Respiratory rate	<= 10% above preoperative value	0
	11% - 30% above preoperative value	1
	31% - 50% above preoperative value	2
	> 50% above preoperative value	3
Arterial blood pressure	<= 10% above preoperative value	0
	11% - 30% above preoperative value	1
	31% - 50% above preoperative value	2
	> 50% above preoperative value	3
Salivation	Normal	0
	Above normal	1
Mydriasis	No	0
	Yes	1
Vocalization	Quiet	0
	Crying, responds to calming attempts	1
	Crying no response	2
Agitation	Asleep or calm	0
	Mild agitation	1
	Moderate agitation	2
Body position	Severe agitation	0
	Sternal and relaxed	1
	Protecting the incision site, including lateral and fetal position	2
Response to palpation of the incision site	No response	0
	Mild response, looks at incision site	1
	Turns head for the incision site, mild vocalization	2
	Turns head with intention to bite, severe vocalization	3

Venous blood samples were collected from the jugular vein to measure of cortisol before the pre-anesthetic medication was administered (basal), at 1, 12 and 24 hours post-ovariohysterectomy. Serum samples were stored at -70 C and analyzed within 12 months after collection. Cortisol levels were quantified using a solid-phase radioimmunoassay (Coat-A-Count Cortisol - DPC, California, USA).

The occurrence of adverse effects such as nausea, vomiting, tremors, excitement and drooling were also recorded.

Data were recorded as mean±SD. The data analyzed using an analysis of variance with the F test followed by Tukey's test using Graphpad software. Differences between treatments at each time point, differences in time for each treatment, and the interaction between treatment and time were investigated. A p-value less than 0.05 was considered significant.

Results

There were no differences ($P>0.05$) between the groups in terms of mean surgical time (37 ± 3 , 39 ± 8 minutes and 32 ± 8 for the EA, DER and EAD groups, respectively), extubation time (5 ± 3 , 4.5 ± 2 and 6 ± 8 minutes for the EA, DER and EAD groups, respectively) and recovery time (25 ± 5 , 21 ± 7 minutes and 23 ± 4 for the EA, DER and EAD groups, respectively).

The median pain scores were significantly lower in the EA and EAD treatments when compared with DER treatment at first hour postoperative (Figure 1).

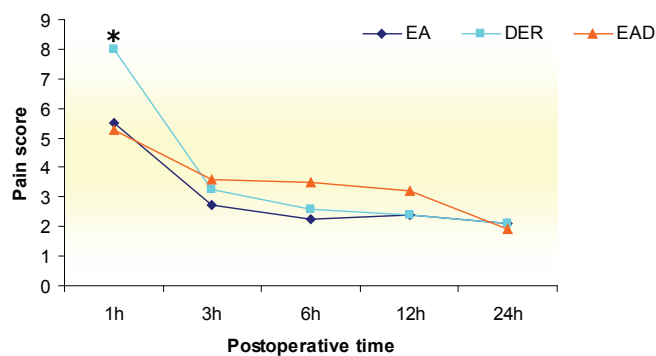


FIGURE 1 - Mean of pain score in dogs treated with electrical stimulation of acupoints ST36, SP6 and GB34 (EA, n=6), electrical stimulation at peri-incisional dermatomes (DER, n=6) and electrical stimulation at acupoints ST36, SP6 and GB34 plus peri-incisional dermatomes (EAD, n=6). * $P<0.05$, significant increase when compared with EA and EAD treatments.

Two out of six dogs (33.3%) in the EA and EAD groups and five out of six dogs (83.3%) in the DER group required

additional analgesia at first three hours postoperative (Figure 2).

Serum cortisol were significantly higher at one hour postoperative than baseline cortisol concentrations and returned to basal values at 24 hours postoperative (Figure 3).

Undesirable side effects were not observed in any of the dogs.

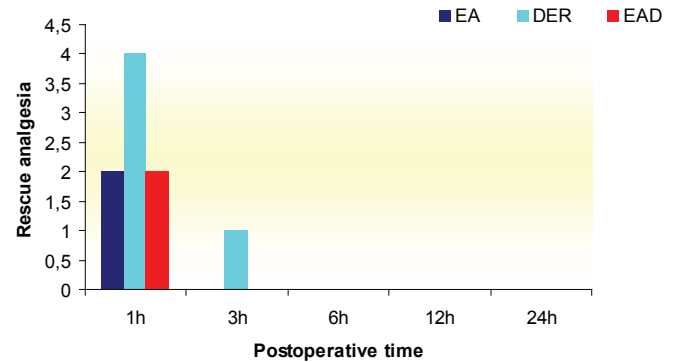


FIGURE 2 – Number of dogs that required rescue analgesia at postoperative time.

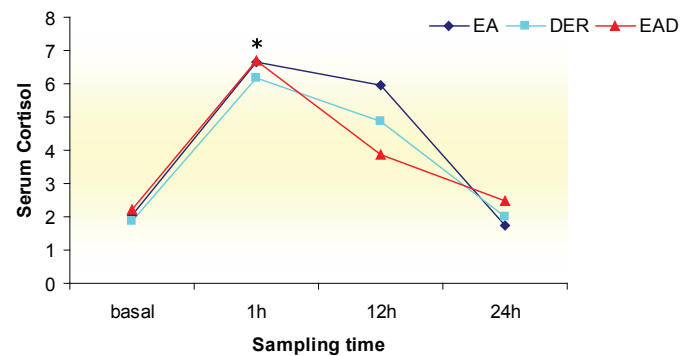


FIGURE 3 - Mean serum cortisol concentration ($\mu\text{g.dl}^{-1}$) in dogs treated with electrical stimulation at acupoints ST36, SP6 and GB34 (EA, n=6), electrical stimulation at peri-incisional dermatomes (DER, n=6) and electrical stimulation at acupoints ST36, SP6 and GB34 plus peri-incisional dermatomes (EAD, n=6). * $P<0.05$, significant increase when compared with the baseline values and with the 24 hours postoperative.

Discussion

The current study confirms previous reports in humans which have shown satisfactory postoperative analgesia following preoperative application of electrical stimulation at the traditional Chinese acupoints isolated^{2,4,5,13} or in combination with electrical stimulation at the dermatomal level of the skin incision^{8,9}. In both groups (EA and EAD), the pain scores were lower at the first hour post-ovariohysterectomy when compared with DER treatment. Additionally, rescue analgesia was more frequent in DER treatment, while in EA and EAD treatments a few dogs needed

supplemental analgesia, implying that both regimens provide adequate analgesia.

The mechanism by which acupuncture produces analgesia remains unclear⁴. Some authors^{9,13,14} agree with the classic “gate control theory”¹⁵, which supports that the stimulus promoted by needles introduced intradermally can activate large nerve fibers (A β fibers) and change pain perception in spinal cord⁴. There is evidence showing that acupuncture stimulates the pain inhibitory system at the spinal cord, brainstem and other areas of the central nervous system, such as thalamus, 3rd ventricle, mesencephalon, diencephalon, hypothalamus and hypophysis. Endogenous opioids, such as endorphins, enkephalins and dynorphins also contribute to the analgesic effect of acupuncture¹⁶.

The acupoints selected in the present study have produced analgesia in several other studies^{5,14,19,20}. According to Traditional Chinese Medicine, the ST36 acupoints are highly effective in relieving abdominal pain⁸. Additionally, the characteristics of the electrostimulation used also played an important analgesic role. The dense-disperse mode, with frequency ranging from 3 to 200 Hz, promotes the release of different types of endogenous opiates. Application of low-frequency EA (2 Hz) accelerates the central release of enkephalin and β endorphin, whereas EA at high frequency (100 Hz) induces dinorphin release by the spinal cord²¹. Electroanalgesia techniques, such as transcutaneous and percutaneous electrical stimulation, also promotes enhanced analgesia when used at mixed frequencies rather than when used exclusively at either low or high frequency^{22,23}.

The poor postoperative analgesic effect found in DER treated dogs is consistent with previous studies in humans¹⁷⁻¹⁹ which suggest that the application of electrical stimulus at the peri-incisional dermatomes appears to be most effective for the superficial cutaneous component of postoperative pain, leaving the deep visceral pain component largely intact. It seems likely that electrical nerve stimulation near the incision site mainly stimulates specific afferent nerve fibers instead of triggering endogenous opioid-release mechanisms¹⁷. However, despite EA and EAD treatments provided better analgesia than DER treatment, the lack of a significantly difference in pain scores among treatments groups at 3, 6, 12 and 24 hours postoperative can easily be explained by the analgesic effect mediated by the supplemental morphine. These findings are consistent with results of other studies^{24,25}. The most (83.3%) of the DER treated dogs received supplemental morphine at 1 and 3 hours postoperative, while only 33.3% dogs in EA and EAD treatments were given rescue analgesia.

Anesthesia, surgical trauma and postoperative pain elicit

an endocrine response characterized by increased production of catecholamines and cortisol¹¹. In the current study, in all treatments groups, serum cortisol did not exceed the reference range (0.96 to 6.81 g/dl) at any evaluated time point. However, in all groups, serum cortisol levels were highest at 1 hour postoperative, which agrees with previous studies^{11,25,26}. As time progressed, the cortisol concentration returned to baseline values by 24 hours postoperative. There was a poor correlation between pain scores and serum cortisol concentration, corroborating other studies²⁷⁻²⁹. Although, the maximum pain scores and the maximum cortisol levels were observed at first hour after surgery, DER treated dogs had the most pain, but their serum cortisol levels were not higher than the other groups. However, serum cortisol concentration is not pathognomonic for pain²⁵, and conditions such as handling, fear, differences in temperament of individual dogs are non-pain related and can stimulate stress responses¹¹.

Conclusion

The results of this study suggest that preoperative application of electrical stimulation at the acupoints ST 36, SP 6 and GB 34 isolated or in combination with electrical stimulation at the dermatomal level of the skin incision reduce the postoperative opioid requirement, resulting in a safe option for analgesia in dogs undergoing ovariohysterectomy.

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