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Effectiveness of electroacupuncture analgesia compared with opioid administration in a dog model: a pilot study

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Editor's key points

- Electroacupuncture was compared with conventional opioid pain relief in female dogs undergoing elective neutering.
- Pain relief was better and more prolonged in dogs receiving acupuncture than butorphanol.
- No dogs receiving acupuncture needed breakthrough pain relief.

Background. Although opioid analgesics are the usual drugs to treat post-surgical pain, acupuncture has also been demonstrated to relieve various pain syndromes. The present pilot study aims to investigate the efficacy of electroacupuncture compared with a conventional opioid compound, butorphanol, for postoperative pain treatment in dogs undergoing elective ovariohysterectomy.

Methods. Twelve dogs were randomly allocated into two groups. Dogs received either electroacupuncture stimulation (16 and 43 Hz) at *Shen Shu, Chang Shu, He Gu, Tai Yuan, Zu San Li, Yang Ling Quan*, and *Bai Hui* acupoints, while control dogs were treated with butorphanol. Cardiovascular and respiratory parameters were recorded for both groups during operation. Plasma β-endorphin concentrations were evaluated before surgery (baseline) and up to 24 h later. For each dog, pain was measured according to a dedicated subjective pain scoring system.

Results. Plasma β-endorphin levels in dogs receiving electroacupuncture increased significantly against baseline values after 1 and 3 h after surgery. Moreover, the end-tidal isoflurane concentration needed for second ovary traction was significantly lower in acupuncture-treated dogs than control animals. All animals having electroacupuncture experienced prolonged analgesia, over 24 h at least, while four out of six dogs treated with butorphanol needed post-surgical ketorolac and tramadol supplementation to their pain relief.

Conclusions. The results obtained from the present investigation showed some evidence for electroacupuncture as an alternative technique to provide postoperative analgesia in dogs.

Keywords: analgesia; butorphanol; dog; electroacupuncture; ovariohysterectomy

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Acupuncture is a medical technique experienced in the Eastern world since 3000–5000 yr ago. In Western countries, though its scientific efficacy remained controversial for many years, it was only recognized as a complementary medical treatment by the US National Institutes of Health.[1]

Endogenous opioids peptides are considered to play a central role in mediating the analgesic effect of acupuncture;[2] in fact, many studies have shown that acupuncture can increase endorphin levels in the brain, spinal cord, and plasma.[3 4] Electroacupuncture can even be of greater efficacy than dry needles alone as it produces a stronger, more prolonged, and uniform stimulation.[5] It has to be noted that different neuropeptides are released according to different frequencies of electroacupuncture.[2] In fact, previous studies conducted on a rodent model found that a moderate frequency (10–100 Hz) can produce a significant anti-hyperalgesic effect.[6 7] Analgesia induced by a moderate frequency electroacupuncture is mediated by endomorphin (μ-opioid agonist), dynorphin (κ-opioid agonist), enkephalin, and β-endorphin (mixed μ- and δ-opioid agonist) release.[2] The present study aimed to compare the postoperative pain relief induced by electroacupuncture (16 and 43 Hz) compared with a conventional analgesic opioid, butorphanol, in dogs undergoing routine elective ovariohysterectomy. In our investigation, we assumed that the analgesic effects of electroacupuncture treatment are mediated by central opioid activity via the β-endorphin system.

Methods

This experiment complied with the guidelines of the Committee for Research and Ethical Issue of IASP.[8] The study protocol was approved by the institutional ethical committee of Università degli Studi di Milano, Italy.

Animals

Consistent with Italian regulations (D.L. 116/1992), due consent was obtained from the owners of dogs in need of ovariohysterectomy to be performed at the Reproduction Unit of the Department of Veterinary Clinical Science, Università degli Studi di Milano, Italy. The dogs were deemed healthy according to the ASA classification I–II, as apparent from physical and haematological examination. Exclusion criteria were the presence of systemic or localized diseases involving cardiovascular, neurological, respiratory, gastrointestinal, or urogenital systems and also the use of any analgesic drug or an alternative analgesic therapy within 14 days of surgery. All dogs in the study were found to be within reference ranges as to their preoperative haematology and biochemical profiles. Twelve healthy sexually intact bitches of different breeds, weighing from 5 to 41.5 kg and aged from 2 to 8 yr, were enrolled in this study and randomly allocated to either an acupuncture-treated ($n=6$) or control (usual practice) group ($n=6$). Mean (range) age of dogs was 4.6 (2–8) and 5.3 (3–8) yr and mean (SD) weight was 25.2 (8.3) and 27.5 (1.3) kg for the acupuncture and control groups, respectively. Before operation, treated dogs had electroacupuncture as the only analgesic support to surgery, while control dogs were given butorphanol (Dolorex®, Intervet, Italy). After surgery, all animals were housed in hospital for 24 h to monitor their pain score at specific time points using a subjective pain scoring system modified from Sammarco and colleagues,[9] and to collect blood samples for measurement of endorphin.

Anaesthetic common protocol

All animals were fasted from the evening before surgery, and water was allowed until 2 h before surgery. To obtain effective sedation for electroacupuncture procedures, propofol (Propovet, Esteve spa, Italy) was administered i.v. at 2.5 mg kg^{-1} dose over 30 s followed by a continuous rate infusion of 0.05 mg kg^{-1} min^{-1}. Control dogs received the same sedative protocol. Forty minutes after the first perfusion, anaesthesia was induced in all dogs within an additional bolus of propofol (1 mg kg^{-1}) to allow tracheal intubation. Anaesthesia was maintained by isoflurane (Isoba, Schering-Plough, Italy) using 100% oxygen delivered via a re-breathing system, at the minimum efficacy dose to obtain an appropriate level of anaesthesia based on clinical assessment. The same surgeon performed all operations.

Analgesic protocols

Electroacupuncture treated

Since analgesia requires an induction period of 30–40 min,[10] electroacupuncture was performed 40 min before surgery and maintained until the last skin suture was placed. Frequency and intensity of electroacupuncture and also proper acupoints were selected according to veterinary literature, in agreement with the principles of Traditional Chinese Medicine.[11] In our study, we chose the following acupoints: *Shen Shu* (BL 23), *Chang Shu* (BL 25), *He Gu* (LI 4), *Tai Yuan* (LU 9), *Zu San Li* (ST 36), *Yang Ling Quan* (GB 34), and *Bai Hui* (GV 20). In dogs, GV 20 *Bai Hui* is located on the dorsal midline of their skull, intersecting the coronal line from both sides of the rostral ear base, at the rostral end of the external sagittal crest.[12] Needles (Seirin, soft needle, size 0.30 × 30 mm) were inserted at all acupoint levels to a depth of 15–20 mm. Acupoint GV 20 was stimulated manually every 10 min. Other acupoints were electrically stimulated in pairs using an electronic acupunctoscope [WQ-6F(57–6F), Beijing Haidian, China]. Acupoints LI 4, LU 9, ST 36, and GB 34 were stimulated with 16 Hz and 0.4 V, while acupoints BL 23 and BL 25 received 43 Hz, 0.1 V stimulation. Electroacupuncture needles were glued at their acupoints to avoid being removed by accidental movements of the animals under treatment.

Opioid group (C)

In control dogs, butorphanol (Dolorex®) was administered i.m. at 0.2 mg kg^{-1}, 15 min before surgery.

Surgery

Ovariohysterectomy was performed using a standard technique through median laparotomy access in supine bitches.[13] Monitoring included measurement of Sp_{O_2}, heart rate, arterial pressure, Et-ISF%, E'_{CO_2}, E'_{O_2}, temperature, and ECG—all performed by a multi-parametric monitor (Goldway UT 4000F pro; Smithtown, NY, USA). Named parameters were recorded for all bitches every 5 min during anaesthesia and surgery. Statistical evaluations were performed just before skin incision (T1), at skin incision (T2), at the first ovary traction, at the second ovary traction (T3), and at the end of skin suture (T4).

Postoperative pain assessment

Postoperative pain was assessed by three independent trained observers who were blinded to the dogs treatment group, using a modification of Sammarco and colleagues'[9] subjective pain scoring system, at 0 (T4), 15, 30, 45 min, 1 h (T5), 2, 3 h (T6), 4, 5, 6 h (T7), 8, 10, 12 h (T8), and 24 h (T9) after tracheal extubation (Table 1). This score consists of six behavioural categories represented by the following descriptive expressions: comfort, movement, appearance, unprovoked behaviour, interactive behaviour, and vocalization. Each category is then subdivided into levels in ascending order related to pain intensity, with a maximum pain score of 24. When scores exceeded 6/24 (indicating moderate/severe pain), rescue analgesia was administered by i.m. injection of 0.5 mg kg^{-1} ketorolac tromethamine (Toradol®, Recordati spa, Italy) and 4 mg kg^{-1} tramadol chlorhydrate (Altadol, Formevet spa, Italy); after such occurrence data were recorded but excluded from statistical analysis.

Blood analysis

To minimize stress associated with blood sample acquisition, two 18 G i.v. catheters were aseptically placed bilaterally into the cephalic vein of all bitches just 10 min before measuring β-endorphin by a first blood collection (T0). Serial peripheral blood sampling after 40 min (T1), at skin incision (T2), at the second ovary traction (T3), and at the end of last skin suture