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Clinical Studies

Evaluating the Efficacy of Electro-acupuncture Integrated into a Multi-modal Pain Management Protocol for Canine Dental Extractions: A Pilot Study

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ABSTRACT

The objective of this study was to determine the efficacy of integrating electro-acupuncture (EAP) into a multi-modal pain management protocol during canine surgical dental extractions. Thirty dogs undergoing surgical extraction of fractured or diseased teeth were enrolled and randomly assigned to the Test Group (EAP) or Control Group (EAP non-relevant acupoints). All subjects underwent standard anesthetic procedure before receiving study group electro-acupuncture. The Test Group had needles placed bilaterally at *Tai-yang*+ST-42 and LI-4+ST-6 with 20 minutes of electrical stimulation. The Control Group had needles placed bilaterally at non-relevant acupoints, BL-20+GB-34 and LIV-13+KID-3, with the same electrical stimulation settings. A cumulative pain score based on the modified Glasgow Composite Pain Scale (mGCPS), consisting of assessments of 4 behaviors (vocalization, response to touch, demeanor, and posture/activity), was first collected at 30 minutes, then at 1, 2, 4, and 24 hours after extubation. This data was used for comparison of treatment effects between the 2 study groups. Patient physiological data, collected at the same time as behavior assessments, included heart rate (HR), respiratory rate (RR), and body temperature (BT). Compared with the Control Group, the Test Group's mGCPS score was 42%, 35%, 24%, 41%, and 60% lower at 30 minutes, 1, 2, 4, and 24 hours, respectively, after extubation. The Test Group also had lower post-extubation HR (21%) and RR (10%) compared to Control Group. The findings suggest that integrating EAP in a multi-modal pain management protocol during canine surgical dental extractions could enhance the efficiency of pain management.

Keywords: canine surgery dental extraction, electro-acupuncture, modified Glasgow Composite Pain Scale, pain management

ABBREVIATIONS: AP: acupuncture; BT: body temperature; CVT: certified veterinary technician; EAP: electro-acupuncture; HR: heart rate; mGCPS: modified Glasgow Composite Pain Scale; NSAIDs: non-steroidal anti-inflammatory drugs; RR: respiratory rate; TCVM: traditional Chinese veterinary medicine

Dental disease is very common in small animals, making oral surgery a standard procedure at veterinary clinics. Indications for dental extractions include tooth fractures, periodontal disease, and dental abscesses. These interventions are frequently required in geriatric patients suffering from metabolic conditions, which can increase risk. Identifying safe anesthetic and pain management strategies is particularly important for these populations. Currently, the standard of care for managing moderate surgical pain in canine dental procedures comprises general anesthesia, local anesthetic blocks, opioid analgesics, and non-steroidal anti-inflammatory drugs (NSAIDs) when not contraindicated.[1,2] Literature supports that perioperative NSAID administration significantly enhances postoperative pain control and attenuates inflammation following surgical intervention.[3,4] The use of NSAIDs, however, is associated with a range of adverse effects and contraindications, including gastrointestinal upset (vomiting, diarrhea), anorexia, and potential hepatic or renal impairment. For this reason, their use should be judiciously avoided or closely monitored in patients with existing hepatic or renal dysfunction. Local anesthetic blocks are now part of standard of care, though challenges persist regarding the proper technique for regional blocks, optimal dosing, and precise delivery to achieve maximal analgesic efficacy. Moreover, practitioners must be aware of rare but serious complications such as cardiotoxicity linked to regional anesthetics.[5]

Acupuncture (AP) has gained increasing acceptance as an adjunctive treatment for painful conditions over the last several decades. The National Institute of Health (NIH)

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and the World Health Organization (WHO) have made statements on its benefits, with WHO listing dental, post-operative, and facial pain as conditions AP can be used for. Additionally, AP has been proposed as an adjunctive treatment in human dentistry to reduce anxiety and relieve facial pain. The idea of using AP for pain control in animals undergoing surgery is not new, as this idea has been in the literature for at least 20 years.[6] Further research is required, as current evidence remains inconclusive. The American Animal Hospital Association (AAHA) has similarly advocated for more studies and has not taken a definitive position regarding the efficacy of AP in managing pain in companion animals.[7]

While there have been several studies looking at AP as an adjunct to pain management for moderately painful procedures such as ovariohysterectomy (OVH) and mass removals, to the author's knowledge, there are no studies exploring AP as a part of the pain management protocol for dental extractions in veterinary patients.[6,8-17] The objective of this study was to determine the efficacy of integrating electro-acupuncture (EAP) as part of a multi-modal pain management protocol during surgical dental extractions in dogs. The hypothesis was that canine patients receiving test EAP treatment would show improved pain management during tooth extraction, as evidenced by post-extubation pain scores and physiologic data, compared to those in the Control Group (non-relevant EAP).

MATERIALS AND METHODS

Animals

The subject population consisted of canine patients that required surgical extractions for fractured or diseased teeth. Surgical extractions were defined as extractions which required creation of a gingival flap and the use of a dental drill to remove alveolar bone surrounding the tooth to be removed. Subjects were recruited from the patient population of Green Valley Veterinary Hospital in New Brighton, Pennsylvania, an AAHA accredited private practice. All healthy dogs aged between 1 and 13 years old were invited to participate, regardless of breed, sex, and body weight. Inclusion criteria included normal findings on a clinical chemistry panel, complete blood count, and urinalysis within 30 days of study start. Exclusion criteria were any documented underlying metabolic disease such as diabetes, liver disease [elevated alanine transaminase (ALT)>50% above normal], stage 2 renal disease [symmetric dimethylarginine (SDMA)>25 mg/dL] or a known seizure history. Total anesthesia time exceeding 120 minutes or extractions on more than 2 dental arcades were also exclusion criteria. Patients with liver or kidney disease were excluded due to the 4.4 mg/kg dosing of an NSAID (carprofen), so were the patients with a known seizure history as EAP around the face and head is contraindicated in patients with seizures.

Experimental Procedure

Study Design: The subjects enrolled were randomly assigned into Test Group or Control Group. The groups were matched for age and sex as best as possible with stratified randomization. Patients, ranging in age from one to thirteen years of age were placed into 4 sequential age groups: 1-4 years, 4-7 years, 7-10 years, and 10-13 years of age. Dogs at the highest age specified within an age group were considered part of the next higher group rather than remaining in the younger category. The subjects were categorized into 8 blocks (4 Age Groups × 2 Sex Groups). Simple randomization (by coin toss) was performed within each block of subjects.

Each subject had an intravenous catheter placed and was sedated with hydromorphone[a] (0.1 mg/kg) and midazolam[b] (0.2 mg/kg IV). Propofol[c] anesthesia (2 mg/kg IV boluses) to effect was used for induction. The patient was then intubated and maintained on isoflurane[d] anesthesia. Patients also received an injection of carprofen[e] (4 mg/kg SC), maropitant citrate[f] (1 mg/kg SC) and intravenous fluids[g] at a rate of 5 mL/kg/hr during the procedure. Once under general anesthesia, dental radiographs were taken.

Following dental imaging, acupuncture treatment was begun with each patient prepared for Test Group EAP or Control Group (non-relevant) EAP. A certified veterinary acupuncturist (CVA) inserted the acupuncture needles[h] (32 g × 0.5 in), secured them with surgical adhesive[i], and attached the electric leads. The acupuncture needles were then stimulated with an acupunctoscope[j] (EAP machine) for the first 20 minutes of surgery. Electric stimulation was then stopped, but the needles remained in place until after the dental procedure was finished. The needles were then removed by the CVA who had placed the needles, along with removal of the adhesive with a waterless shampoo[k]. This process was completed during early anesthesia recovery while the dog was still in the dental area being monitored by certified veterinary technicians (CVTs) assigned to the dental procedure area. Once the dog could swallow twice, the endotracheal tube was removed and the animal was then brought to the recovery cage. At this point, a different set of CVTs, who had not attended the dog during surgery, and were blinded to study groups, monitored the patient and collected the study data.

Acupuncture: The Control Group had acupuncture needles placed bilaterally at BL-20, GB-34, LIV-13 and KID-3 with the following pairings: (1) BL-20 on the right to GB-34 on the right; (2) BL-20 on the left to GB-34 on the left; (3) LIV-13 on the right to KID-3 on the right; and (4) LIV-13 on the left to KID-3 on the left. Electrical stimulation was performed using an acupunctoscope[j] set at 20 Hz for 10 minutes and 80/120 Hz for 10 minutes. The machine knob setting was placed at "1" for intensity (approximately 3 mA).

The Test Group patients had their acupuncture needles placed bilaterally at *Tai-yang*, ST-42, ST-6 and LI-4 with the following pairings: (1) *Tai-yang* on the right to ST-42 on the right; (2) *Tai-yang* on the left to ST-42 on the left; (3) ST-6 on the right to LI-4 on the right; and (4) ST-6 on the left to LI-4 on the left (Table 1).[18] Electrical stimulation was performed using the same stimulator device with the same stimulation parameters.

Table 1: Acupuncture points and descriptions

Acupoint	Indications for Use	Location
Tai-yang (Great *Yang*)	Dental pain, headache, facial paralysis, conjunctivitis/acute eye problems	1 *cun* caudal to the lateral canthus dorsal to the zygomatic arch
ST-6 (*Jia-che*)	Dental pain, mandible pain, facial paralysis, headache, head shaking	In the depression in the middle of masseter muscle just rostral to the angle of the mandible
ST-42 (*Chong-yang*)	Dental problems, *Yuan* (source) point, facial swelling, facial paralysis, *Wei* syndrome	At the junction of the 3rd and 4th metatarsal bones on the dorsal aspect of the metatarsus
LI-4 (*He-gu*)	Master point of face/mouth, one of the four gate points, promotes *Qi* and Blood flow throughout the body, clear Stagnation	Located between the 2nd and 3rd metacarpal bones at the midpoint of the 3rd metacarpal bone on the medial side
BL-20 (*Pi-shu*)	Back-*shu* association point for Spleen Damp, digestive disorders, vomiting, watery, bloody diarrhea, edema, anemia, thoraco-lumbar intervertebral disk disease	1.5 *cun* lateral to the caudal border of the dorsal spinous process of the 12th thoracic vertebrae
GB-34 (*Yang-ling-quan*)	*He*-sea (Earth) point, vomiting, biliary disorders, Influential point for ligaments and tendons. Useful for stifle/general pain, pelvic limb weakness	Located in a depression just cranial and distal to the head of the fibula
KID-3 (*Tai-xi*)	*Shu*-stream (Earth) point for Kidney, *Yuan*-source point for Kidney, *Jing* tonic, renal diseases, dysuria, dyspnea, dental pain, thoracolumbar intervertebral disk disease, otitis	On the caudomedial aspect of the hind limb in the thin fleshy tissue between the medial malleolus and the calcaneus level with the tip of the medial malleolus (opposite and slightly distal to BL-60)
LIV-13 (*Zhang-men*)	Front-*mu* point for Spleen, Influential point for *Yin* organs, colic, diarrhea, muscle pain	On the lateral side of the body just ventral to the free end of the 12th rib

Outcome Data and Statistical Analysis

Data Collection: The study used a cumulative pain score based on the modified Glasgow Composite Pain Scale (mGCPS) that considers 4 behavior assessments: vocalization, response to touch, demeanor, and posture/ activity (Table 2). This scale has been described by other researchers in a study on pain management in dental extractions.[19] Measurements were taken at 30 minutes, 1, 2, 4, and 24 hours after extubation by CVTs. The mGCPS was reviewed with the CVTs prior to the start of the study and the same two CVTs took the mGCPS readings during the study to maintain consistency. Post-extubation physiological data including heart rate (HR), respiratory rate (RR), and body temperature (BT) were also recorded at 30 minutes, 1, 2, and 4 hours after the extubation.

To maintain the blinding of the study, the CVTs monitoring anesthesia and assisting with the dental procedure were not the same CVTs that recorded pain scores and physiological data in the post-operative period. While the study was conducted, the hospital employed five to seven CVTs. This allowed two CVTs to join the surgical team, while a third monitored patients post-operatively and recorded pain scores without knowledge of needle placement. This prevented a CVT recording pain scores from knowing where the needles had been placed on a patient. Owners, blinded to study group, collected 24-hour pain scores after discharge. The CVTs in recovery reviewed the mGCPs pain scale with owners at discharge.

Table 2: Modified Glasgow Composite Pain Scale

Behavior Category	Score	Description
Vocalization	0	Quiet
	1	Whimpering or crying
	2	Groaning
	3	Screaming
Response to touch	0	Does nothing
	1	Looks around
	2	Flinches
	3	Growls or guards area
	4	Snaps
	5	Cries
Demeanor	0	Happy/content/bouncy
	1	Quiet
	2	Indifferent or nonresponsive to surroundings
	3	Nervous, anxious or fearful
	4	Depressed or non-responsive to stimulation
Posture/ Activity	0	Comfortable
	1	Unsettled
	2	Restless
	3	Hunched or tense
	4	Rigid

Statistical Analysis: As this was a small sample size pilot study to generate useful information for future large scaled clinical studies, predominately descriptive statistics (such as mean, SD, % difference from the Control Group) were used to observe the trends of the treatment effects. Nonetheless, some simple statistical inference was also performed to determine if any findings had a strong effect. For example, based on the outcome measurements described above, the study tested the following statistical hypotheses: H_0 – There is no group effect on the post-extubation mean mGCPS score; vs. H_A – There exists a group effect on the post-extubation mean mGCPS score. The hypothesis was evaluated using repeated-measure ANOVA on ranked mGCPS data, appropriate for ordinal-scale measurements. Additionally, the study compared mean mGCPS scores between the two treatment groups at each of the five post-extubation assessments; for each comparison, a one-sided Wilcoxon Rank Sum Test was conducted to assess whether the Test Group demonstrated superior mGCPS scores relative to the Control Group. For all tests, significance level was set at 0.05 (i.e. null hypothesis was rejected when p-value≤0.05). All statistical analyses were performed using the statistical software R[L].

RESULTS

Thirty subjects meeting the inclusion and exclusion criteria were enrolled in the study. The randomization procedure resulted in 15 assigned to the Control Group and the other 15 to the Test Group. All subjects completed the study. Patient signalment data, including sex, age, and weight, were compared between the treatment groups for assessing the group comparability. Statistical comparisons did not find significant differences between study groups in sex distribution or age. The control female percentage was 60% versus test female 47% (p=0.715) and age distribution (mean±SD) for controls 7.6±2.5 years versus test patients 7.5±2.7 years (p=0.959). The Test Group weighing 58.8±37.6 pounds (mean±SD), however, was significantly heavier than the Control Group weighing 23.5±20.5 pounds (p=0.003). Both study groups included a variety of different breeds (Table 3).

At each post-extubation assessment, the Test Group had significantly lower mean mGCPS pain scores than the Control Group, except at the 2-hour assessment (Figure 1). Reductions included: 42% at 30 minutes (p=0.006), 35% at 1 hour (p=0.005), 24% at 2 hours (p=0.074), 41% at 4 hours (p=0.008), and 60% at 24 hours (p=0.015) (Table 4). Taking all five mGCPS assessments together and determining whether a group effect existed, the repeated-measure ANOVA found a significant group effect (p=0.001) and time effect (p<0.001), indicating pain declined over time in both groups. No significant interaction was observed (p=0.628), showing consistent group differences across assessments.

Table 3: Summary statistics of patient signalment data

	Control (n = 15)	**Test (n = 15)**	***p*-value**
Sex (female %)	60% (9/15)	47% (7/15)	0.715
Age (years)	7.6±2.5	7.5±2.7	0.959
Weight (lbs)	23.5±20.5	58.8±37.6	0.003**
Number and list of different breeds	13	15	N/A
	Beagle, Chihuahua, Dachshund, Siberian Husky, Jack Russel Terrier, Labrador Retriever, Miniature Schnauzer, Shetland Sheepdog, Mixed-breeds	Australian Shepherd, Golden Retriever, Great Dane, Siberian Husky, Labrador Retriever, Shetland Sheepdog, Yorkshire Terrier, Mixed-breeds	N/A

Statistical significance=p<0.05 (*), p<0.01 (**); N/A=not applicable

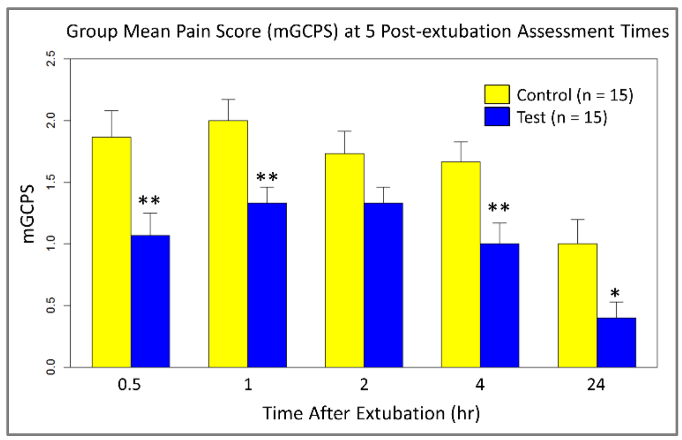

Figure 1: Group mean (with standard error) comparison of mGCPS score at the five different post-extubation assessment times. Statistical significance = *p < 0.05; **p<0.01

Table 4: Overall mGCPS score (mean±SD) within each treatment group at each assessment time

	30 minutes	**1 hr**	**2 hrs**	**4 hrs**	**24 hrs**
Control	1.9±0.8	2.0±0.7	1.7±0.7	1.7±0.6	1.0±0.8
Test	1.1±0.7	1.3±0.5	1.3±0.5	1.0±0.7	0.4±0.5
p-value	0.006**	0.005**	0.074	0.008**	0.015*

Statistical significance = *p<0.05; **p<0.01

The mean HR at the 4 post-extubation time points was compared between groups (Figure 2). At every time point (30 minutes, 1 hour, 2 hours, and 4 hours), the Test Group had a significantly lower mean HR compared to the Control Group (16.4%, 20.4%, 18.8%, and 20.5% reductions), with *p*-values of 0.016, 0.001, 0.002, and 0.0002, respectively (Table 5). The overall "group" effect on HR was significant, as indicated by a repeated-measures ANOVA (*p*=0.002). Similar to the observations in HR, the mean RR in the Test Group was consistently lower than in the Control Group across all 4 assessment times (Figure 3). The differences (9.2%, 15.4%, 12.9%, and 9.7% reductions from the Control Group), however, did not reach statistical significance, along with a non-significant overall "group" effect (*p*=0.336, Table 6). The Test Group had a higher mean temperature than the Control Group at all post-extubation assessments, however, these differences (0.5%, 0.3%, 0.3%, and 0.4% increases from the Control Group) were also not significant (Figure 4, Table 7). Different from HR and RR, both Groups showed increased BT over time (*p*<0.001).

Table 5: Post-extubation heart rate (HR, beats/min) (mean±SD) within each treatment group at each assessment time

	30 minutes	1 hr	2 hrs	4 hrs
Control	108.3±20.8	109.9±21.2	109.3±18.2	107.7±16.5
Test	90.5±17.9	87.5±14.6	88.8±16.6	85.6±13.2
p-value	0.016*	0.001**	0.002**	0.0002**

Statistical significance = **p*<0.05; ***p*<0.01

Table 6: Post-extubation respiratory rate (RR, breaths/min) (mean±SD) within each treatment group at each assessment time

	30 minutes	1 hr	2 hrs	4 hrs
Control	28.3±10.1	29.3±9.5	27.2±8.7	26.9±10.0
Test	25.7±9.5	24.8±8.8	23.7±9.3	24.3±9.1
p-value	0.238	0.106	0.191	0.283

Table 7: Post-extubation body temperature (BT, °F) (mean±SD) within each treatment group at each assessment time

	30 minutes	1 hr	2 hrs	4 hrs
Control	99.7±1.3	99.9±1.3	100.4±1.3	100.8±1.2
Test	100.2±1.4	100.2±1.2	100.7±0.9	101.2±0.8
p-value	0.180	0.203	0.173	0.102

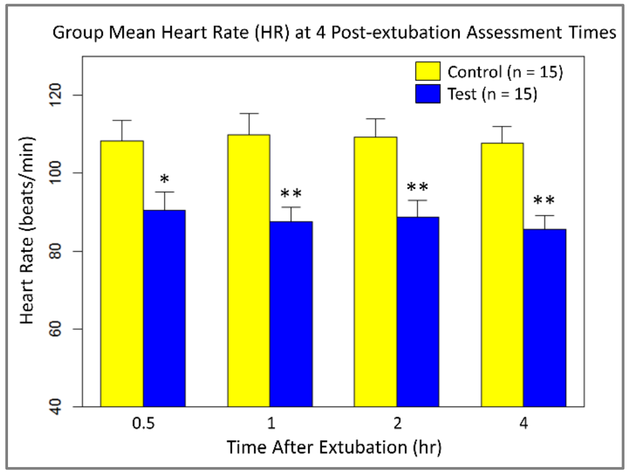

Figure 2: Group mean (with standard error) comparison of post-extubation HR (beats/min) at the four different assessment times; **p*<0.05; ***p*<0.01 compared to the Control Group

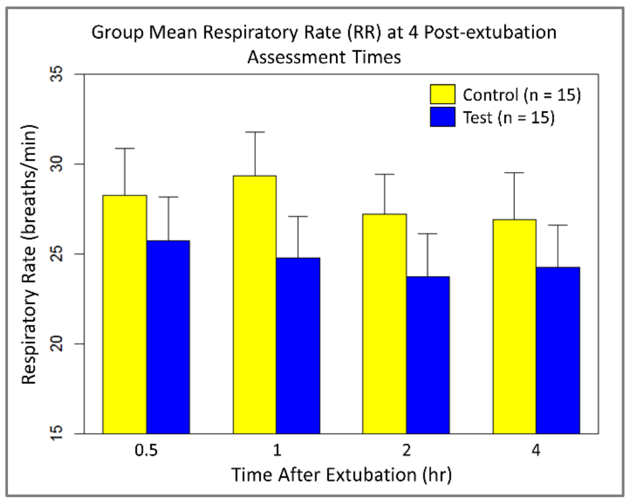

Figure 3: Group mean (with standard error) comparison of post-extubation RR (breaths/min) at the four different assessment times. No significant group difference was concluded at any assessment time.

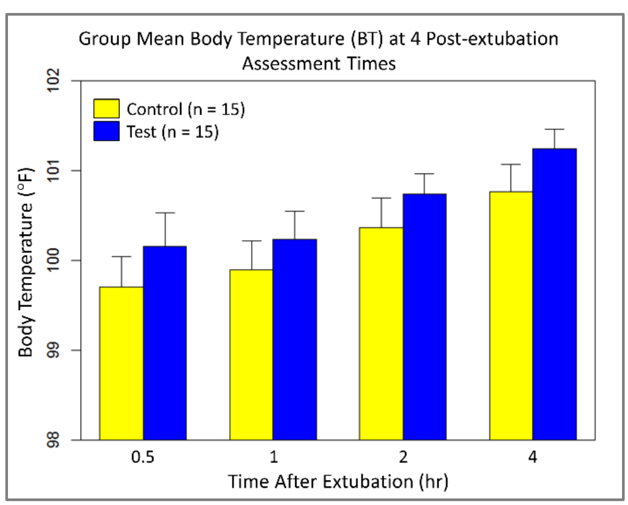

Figure 4: Group mean (with standard error) comparison of post-extubation BT (°F) at the four different assessment times. No significant group difference was concluded at any assessment time.

DISCUSSION

Oral surgery in dogs represents a frequent and important veterinary procedure, often accompanied by significant discomfort and necessitating effective pain management strategies throughout the perioperative period. This randomized controlled pilot study of 30 dogs tested the efficacy of electro-acupuncture (EAP) as part of a multi-modal pain protocol during dental extractions. Study dogs in the Test Group had significantly lower (better) modified Glasgow Composite Pain Scores (mGCPS) when compared to the Control Group when assessed at five post-extubation timepoints over 24 hours. Pain score reductions in the test dogs included: 42% at 30 minutes, 35% at 1 hour, 24% at 2 hours, 41% at 4 hours, and 60% at 24 hours. Mean heart and respiratory rates were reduced across all assessments, with heart rate reduction statistically significant at all timepoints. The findings of this study supported the hypothesis, that canine patients receiving test EAP treatment would show improved pain management during tooth extraction.

This pilot study provides useful information to be considered for design of a large randomized controlled clinical trial evaluating the addition of EAP as a safe non-pharmacological treatment for improved pain management of canine dental extractions. There was pain score improvement in test dogs at all assessment times which were of the magnitude to reach statistical significance at all time points with the exception of the 2 hours post-extubation. Notably, the Test Group had a sixty percent lower pain score than the Control Group at 24 hours post-operatively. It is important to acknowledge that the owner assessments, were subject to greater variability; nonetheless, it is particularly important that patients be comfortable and pain-free during this period. There was a significant difference at the 24 hours post-operative time for the response to touch, demeanor and posture/activity parameters. Vocalization and response to touch are especially important parameters 24 hours post-operatively, as these behaviors (crying, whining, or touch-aversion) are highly concerning to owners.

Among physiologic measures, only heart rate (HR) showed a significant decrease in all four post-extubation assessments, with the Test Group consistently having lower HR than the controls, indicating less pain. The Test Group also had lower respiratory rates (RR) at the 4 study assessment points, but was not large enough to reach statistical significance and may only reflect variations in anesthesia recovery. A minor body temperature increase when compared to controls was also present in the Test Group. This was unexpected and may be related to the significant weight difference between study groups as well as increased use of warming devices on smaller dogs.

Few clinical studies have investigated the efficacy of acupuncture for dental pain associated with tooth extraction in humans and none were found in veterinary medicine. In humans, both Tavares et al. (24 patients) and Kassis (50 patients) conducted self-controlled studies evaluating the efficacy of acupuncture along with oral analgesics for pain relief for surgical extraction of symmetrically impacted third molars. Patients in the Tavares' study received pre- and post-operative EAP, while the Kassis study used dry needle technique post-operatively. Both studies used AP on one side of the mouth and only oral analgesics for surgery on the opposite side.[20] The studies used visual analog scale (VAS) to document pain and measured the amount of oral analgesic intake (2-72 hours for Tavares, immediate post-surgical to 7 days for Kassis). Both studies demonstrated significantly lower pain scores in the experimental acupuncture treatment group through the 3rd post-operative day, similar to the present study which demonstrated long-lasting improvement extending through the last assessment at 24 hours. Oral analgesic use was significantly reduced in the first study but not the second. A third study of interest was a controlled randomized trial conducted in humans investigating the efficacy of EAP for periodontal flap surgery. Forty-four patients scheduled for the procedure were divided into control (no EAP) and test (bilateral EAP before and after surgery). Pain level and analgesic use were recorded for 7 days. The total mean pain score was significantly lower for the EAP patients when compared to control for the first 2 post-operative days (p<0.01) and on the 3rd through 5th days (p<0.05). No statistically significant difference was found in pain level on the 6th and 7th days. The analgesic use was reduced in the EAP group but the group difference did not reach statistical significance.[21]

Although no veterinary studies have been conducted evaluating acupuncture analgesia associated with tooth extraction in dogs, LLoret-Nadal published a technique paper combining EAP with premedication protocols for common minor surgical procedures in small animal clinics which included dentistry.[22] Guidelines for patient selection, methods to improve EAP efficacy, and selection of acupoints are given. The author promotes the use of local points for quick analgesia and distal acupoints to provide general endorphin-release. The acupuncture points chosen for the test dogs in the present study mirrored that with selection of a combination of both local and distal points. Acupoints selected for the current study included LI-4 as a distal point with stimulation creating release of endorphins, clearing Stagnation (i.e. pain relief) and Master point for the head/face. The second distal point chosen, ST-42, benefits dental issues and facial swelling which often accompanies surgical procedures. Local acupoints included *Tai-yang* and ST-6 which are considered effective for dental pain. The selected non-relevant acupoints were chosen for their distance from the face to avoid local effects, ease of needle placement in a patient in ventral-dorsal recumbency, and needles not easily disrupted during extractions. The EAP frequencies used, 20 Hz and 80/120 Hz were stimulated equally with 20 Hz creating beta-endorphin release, and the higher frequency stimulating the release of serotonin.[18,22]

Studies have shown that acupuncture reduces pain at local, segmental (spinal cord) and suprasegmental (brain) levels.[23] Electro-acupuncture, which was selected for this study, maximizes the effects of acupuncture through the electrical stimulation of needles and offers the advantage of allowing quantitative adjustments to the frequency, duration, and intensity of stimulation.[21] It is thought to work through several different mechanisms of action; for instance, one mechanism described is the release of endogenous opioids at the site of inflammation. Groppetti et al. tested this theory by comparing the effects of EAP to butorphanol in dogs undergoing ovariohysterectomies.[16] The study showed the EAP-treated patients needed less isoflurane anesthesia, had lower post-operative pain scores (similar to this study), and had higher levels of beta-endorphins. This effect is consistent with the finding that stimulation with moderate-frequency electro-acupuncture causes the release of endomorphin, dynorphin, enkephalin, and beta-endorphin, which subsequently work as agonists at the opioid receptors. Furthermore, EAP inhibits COX-2, facilitating increased opioid effects at the site of inflammation and activates the pain inhibition system in several areas of the CNS (brainstem, thalamus, mid-brain, hypothalamus and pituitary).[16,21] These mechanisms are discussed by Gakiya et al. in their study where EAP was compared to sham AP and morphine as part of a pain management protocol in dogs undergoing mastectomies. These researchers found that the patients in the EAP group required less rescue analgesia than the other two groups.[17]

This pilot study revealed several areas that could be improved to strengthen the design and execution of a larger clinical trial. These include: a) enrollment numbers, b) body weight differences, c) control group parameters, d) surgical procedure categorization, e) post-operative warming, and f) owner assessment of pain score.

For point (a), a key limitation was the low enrollment numbers in the present study. It is important to enhance patient recruitment strategies in future studies to address this issue and ensure a robust sample size. For point (b), there was a significant difference in body weight between the two study groups. Although post hoc analysis showed no significant correlation between the observed mGCPS score and subject weight, the potential impact of weight differences on study outcomes should be considered. To mitigate this concern, it is recommended that future studies incorporate weight limitations as part of the exclusion criteria. For point (c), selecting appropriate controls for an acupuncture study presents challenges. In this study, both groups received EAP, with the Control Group receiving acupoints that were not considered optimal for pain relief associated with dental surgery. It is difficult, however, to select acupoints with no beneficial activity for the controls, for example KID-3, which most likely reduced dental pain in the controls and potentially minimized differences between groups in this study. For future studies, the inclusion of a no-treatment Control Group is suggested, despite its own disadvantages. For point (d), the length and invasiveness of surgery were not categorized. Dogs undergoing more extensive procedures were more likely to experience increased pain and slower recovery due to longer anesthetic regimens. Although anesthesia time was limited to under 120 minutes in this study, future protocols should consider using more targeted procedures such as extraction of a fractured carnassial teeth to control for variables such as level of periodontal disease and number of teeth extracted. For point (e), variation in post-operative warming procedures was observed, with smaller dogs receiving more aggressive warming measures. This may have affected body temperature measurements. Ensuring even body weights across groups in future studies could address this issue. For point (f), owner-reported 24-hour pain scores can be biased due to subjectivity and expectations. Despite these limitations, they are valuable and recommended for future studies. Bias can be reduced by providing clear instructions for using the mGCPS and blinding owners to group assignments, as demonstrated in this pilot study.

There are several considerations not used in this pilot study that might be included in future clinical trials. Further investigation of optimal acupoints for dental pain such as ones suggested by LLoret-Nadal, LI-4, ST-44, PC-6, ST-36, TH-17, GV-20, ST-2, ST-5, ST-7, ST-44, and LI-20, are excellent considerations. An especially important parameter in dental surgery to monitor is the ability to eat comfortably. This could be measured as the time post-operatively at which patients are willing to eat. In addition, the duration of improved pain relief should be evaluated also, as human studies have demonstrated effects lasting 3 days or more. In retrospect, utilizing a different pain scale may have enhanced the study. The pain scale used in this study was simple and easy to administer, but this simplicity also introduced limitations. For instance, the scale assigned a score of 1 in the demeanor category to a patient that looked around; a common canine behavior and may not indicate pain. A modified version of the short form Glasgow Composite Pain Scale could offer improvements, scoring pain on a 24-point scale or a 20-point scale for non-ambulatory patients.

In conclusion, this pilot study found that integrating electro-acupuncture into a multi-modal pain management protocol for surgical dental extractions in dogs is both effective and feasible. Electro-acupuncture proved to be a safe, complementary, and cost-effective option that can be administered without extending anesthesia time. These promising results support the conduct of a larger, controlled and randomized study to validate the findings of the pilot study.

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FOOTNOTES

[a] Hydromorphone hydrochloride, Hikama Pharmaceuticals, Berkeley Heights, NJ, USA
[b] Midazolam, Akorn Inc, Lake Forest, IL, USA
[c] PropoFlo 28, Zoetis, Kalamazoo, MI, USA
[d] Isoflurane, MWI, Boise, ID, USA product of India
[e] Carprofen, Zoetis, Kalamazoo, MI, USA
[f] Maropitant citrate, Zoetis, Kalamazoo, MI, USA
[g] Lactated Ringer's Solution, ICU Medical Inc, San Clemente, CA, USA
[h] Jing Mei needles, Wuxi Jiajian Medical Instruments Co, Wuxi, Jiangsu, China
[i] Vetbond™ Tissue Adhesive, 3M Animal Care Products, St Paul, MN, USA
[j] Model JM-3A, Wuxi Jiajian Medical Instruments Co, Wuxi, Jiangsu, China
[k] Fresh 'n Clean Waterless Shampoo, Pet-Ag, Hamphire, IL, USA
[L] R version 4.4.1. The R Foundation for Statistical Computing, Vienna, Austria; http://www.R-project.org

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