

Clinical Studies

Liver-3 Acupoint Effect on Isoflurane Anesthesia Usage During Canine Orchiectomy: A Controlled, Randomized and Blinded Clinical Study

Karen Turner-Knarr DVM

ABSTRACT

The effect of adding Liver-3 (LIV-3) acupuncture point on isoflurane anesthetic usage during orchiectomy surgery was evaluated in a controlled, randomized, blinded study using 32 intact male dogs. The dogs were divided into 2 groups (16 Control Group dogs, 16 Test Group dogs). The control group underwent anesthetic induction followed by maintenance on isoflurane gas using a regular anesthetic protocol. The test group used a regular anesthetic protocol but in addition, acupuncture needles were inserted bilaterally at LIV-3 after the dog was placed in the surgical suite. A technician blinded to treatment group monitored isoflurane (% concentration) anesthetic use needed to maintain a good surgical plane of anesthesia (Stage 3, Plane 2). The initial isoflurane concentration (2%) was compared to actual anesthetic requirement during surgery for both groups. The use of LIV-3 during surgery in test group dogs resulted in a 93.7% reduction of anesthetic ($1.37\% \pm 0.08$) while demanded anesthetic in the control group remained at 2% (2.01 ± 0.05). Comparison of anesthetic use between the 2 groups yielded a statistically significant reduction ($p = 4.30 \times 10^{-6}$) of isoflurane usage by test group dogs of 32%. Study results concluded that the addition of acupuncture needles at LIV-3 enhanced the efficiency of maintaining a good plane of anesthesia with resultant use of less gas anesthetic and stabilized blood pressure during the surgical procedure. The results of this study benefit the veterinary clinician using integrative medicine by providing evidence-based results on the benefits of adding this low cost simple procedure during surgery.

Key Words: Canine, neuter, orchiectomy, surgery, anesthesia, acupuncture, analgesia, integrative medicine

ABBREVIATIONS

TCVM	Traditional Chinese veterinary medicine
LIV-3	Liver-3 acupoint
EAP	Electro-acupuncture
DNAP	Dry needle acupuncture
ECG	Electrocardiogram
POM	Pulse oximetry monitoring
BP	Blood pressure
SQ	Subcutaneous

Inhalation anesthesia facilitated by preanesthetic sedation for smooth induction is the method of choice for maintaining anesthesia for most prolonged surgery procedures. The advantages are a patent airway and rapid control of anesthetic depth accompanied by a quick, smooth recovery.¹ Although mortality rate associated with administration of anesthetics is low, morbidity associated with anesthesia can be significant.² Disadvantages include pronounced cardiovascular depression with hypotension, myocardial depression, and bradycardia.^{3, 4}

The cardiovascular effects can be particularly problematic for geriatric dogs, but young animals may suffer from issues such as hypoglycemia, hypothermia and decreased drug metabolism.³ Breed specific abnormalities such as brachycephalic dogs with upper airway obstruction lend additional considerations to anesthetic protocols.^{1, 2} With these challenges, the use of as little anesthetic as possible to maintain a good surgical plane of anesthesia is a common goal of veterinary surgeons.

Integrative medicine is the pairing of conventional medicine with all appropriate therapeutic options to achieve a unique individualized patient care approach to disease. Traditional Chinese Veterinary Medicine (TCVM) which consists of acupuncture, Chinese herbal medicine, food therapy, and *Tui-na* is an increasingly popular therapy integrated with conventional medicine by veterinarians.⁵ Beneficial effects of acupuncture include improved local vasodilation, increased immune response, release of natural endorphins and analgesic segmental effects on the spinal cord.⁶⁻⁹ It is considered a safe treatment and is used to treat a variety of diseases.¹⁰⁻¹²

An additional benefit of acupuncture is its application during surgery to enhance analgesia and endorphin

From: East Ridge Animal Hospital, Chattanooga, TN

release.⁵ From a TCVM perspective, any surgery will lead to Qi-Blood Stagnation. The incision, the manipulation of tissues and organs along with sutures and scar tissue all cause local blockage of Qi that leads to Qi-Blood Stagnation. The acupuncture point, LIV-3, is the third level of the 5 *Shu* transportation points.¹³ Each of the 5 *Shu*-transporting points has a different level and a different disease indication for the use of the acupoint at that level. The location of LIV-3 at the 3rd level (3rd most distal point of its channel) identifies it as effective for controlling Qi-Blood Stagnation and pain. In addition, this acupoint is a *Yuan*-source point with Qi originating from Kidney essence. Each channel has 1 *Yuan*-source point which is commonly used for any disorder of that internal *Zang-Fu* organ. LIV-3, as the *Yuan*-source point of the Liver Channel is often used to treat and prevent Liver Qi Stagnation. The main physiology of Liver Qi is to maintain the smoothness of Qi flow of the whole body. Thus, LIV-3 is often used for general Qi-Blood Stagnation and pain management.¹³

It has been shown that acupuncture can enhance analgesic properties in patients with chronic pain.¹⁴ This suggests that it would enhance a patient's analgesia during surgery. Based on experience by the author during surgery, it was noted that patients receiving acupuncture stimulation during procedures required less anesthesia and enjoyed smoother, faster recoveries. Based on a review of the literature, to the author's knowledge, there have been no studies quantifying inhalation anesthetic use in dogs while undergoing dry needle acupuncture stimulation during a surgical procedure.

The objective of this randomized controlled canine clinical study was to demonstrate that dry needle stimulation of an acupuncture point such as LIV-3, which treats Stagnation, could enhance the efficiency of anesthetic use during a common surgical procedure such as canine orchietomy. The experimental hypothesis was that the integration of dry needle acupuncture during a conventional surgical anesthetic protocol would decrease the dose of inhalation anesthetic (isoflurane) needed to maintain a good plane of anesthesia by at least 10%.

MATERIALS AND METHODS

Dogs for this study were recruited from 1 private practice and 3 different animal shelters in the United States: East Ridge Animal Hospital clients in Chattanooga, Tennessee; Walker County Georgia Humane Society; the Humane Educational Society of Chattanooga Tennessee and the East Ridge, Tennessee Animal Services. All dog owners and shelter directors were advised of the study and were required to sign a surgical release form. A verbal agreement was also obtained which gave permission to use anesthetic values from their dog in a publication. Study dogs in shelters were housed and fed according to guidelines for standards of care in animal shelters.¹⁵ Privately owned animals were housed at home with owners on a variety of diets. The control and treatment

groups were not known to dog owners or shelter directors until after the surgery had been performed.

Inclusion criteria for the study were dogs of any body weight over 5 months old with normal descended testicles, heartworm negative or on heartworm preventative along with current rabies, distemper/parvovirus and Bordetella vaccines. Any animal with a chronic disease was excluded from study participation. As a dog was identified for inclusion in the study, it was randomly assigned to 1 of 2 groups by a coin toss. If the coin was heads, the dog received acupuncture (treatment group) and if tails, the dog did not (control group).

A complete physical was performed on each dog before surgery (Figure 1). Temperature, pulse, and respiration rate were noted. Each dog was pre-sedated with morphine^a at a dose of 0.22mg/kg by subcutaneous injection (SQ).¹⁶ An average of 30-45 minutes elapsed before the dog was induced with Telazol^b (tiletamine) at a dose of 1.1mg/kg by intravenous injection (IV) and intubated.¹⁶ The dog was then maintained on 2.0% isoflurane gas^c anesthesia while aseptically prepared for surgery and placed in the surgery suite where electrocardiogram (ECG), pulse oximetry monitoring (POM), blood pressure (BP) and temperature probes were attached (Figure 2). The veterinary technician who monitored the anesthesia left the surgery suite while the author applied the acupuncture needles bilaterally at LIV-3 in the treatment group (Table 1, Figure 3). The acupuncture needles used were 32x0.5 copper needles^d. The control and treatment groups' rear feet were covered with pipe insulation so that the veterinary technician who monitored and recorded vitals and isoflurane concentration was blinded to the group assignments. Care was taken to only cover the needles and not displace their location in study dogs (Figure 4). After the back feet were covered, the veterinary technician returned to monitor anesthetic values (Figure 5).

The dog's vitals; electrocardiogram (ECG), pulse oximetry monitoring (POM), blood pressure (BP), temperature, heart rate, jaw tone and eye position were noted by the veterinary technician and then monitored (Figure 6). The first isoflurane concentration reading (measured as % concentration) was taken just before the start of the surgery and the surgical drape was applied. After the first reading, one or two readings were taken during surgery depending on the length of the surgery. A "closed" neuter, in which the vaginal tunic was not incised was performed on all surgery participants by the author. The last reading of isoflurane concentration was taken at the end of surgery.

The stages of anesthesia defined for this study were: Stage 1- period between the administration of an anesthetic and unconsciousness; Stage 2- the period after loss of consciousness when there can be a period of excitement and Stage 3 which is divided into four planes. Plane 1 is "light" anesthesia where blinking and swallowing reflexes remain. Plane 2 has loss of blink and swallowing reflex

Physical Exam Form	
Pet Info: Test Group: Study Animal #16 East Ridge Animal Hospital, Canine, Retriever, Labrador Mix, 7 Mos. 1 Wks. 0 Days, Male	
Date:	
Dr. Knarr	Assistant: Angela
History (Subjective)	
1. Have you noticed any issues/problems with your pet? none 2. Is Test Group #16 on heartworm preventative? ☐ Yes ☐ No 3. Does Test Group #16 spend time outside? ☒ Yes ☐ No 4. Have you seen any fleas or ticks on your pet? ☐ Yes ☒ No	
Vital Signs	
Temperature: 100.4 After sx: 99.8 Pulse: 120 Respiration Rate: 30 Weight: 56 pounds	
Physical Exam Findings	
Ears ☒ Normal ☐ Did Not Examine ☐ Abnormal Remarks:	Behavior ☒ Normal ☐ Did Not Examine ☐ Abnormal:
Respiratory ☒ Normal ☐ Did Not Examine ☐ Abnormal Remarks:	Mouth/Teeth/Gum ☒ Normal ☐ Did Not Examine ☐ Deciduous teeth present: ____ ☐ Abnormal Remarks:
Eyes ☒ Normal ☐ Did Not Examine ☐ Abnormal Remarks:	Dental Grade Your pet's dental grade is <u>0</u> out of 4. 0 is healthy gingiva. 1 is tartar with gingivitis. 2 is early periodontitis. 3 is moderate periodontitis. 4 is advanced periodontitis.
Lymph Nodes ☒ Normal ☐ Did Not Examine ☐ Enlarged : ☐ Abnormal Remarks:	Coat and Skin ☒ Normal ☐ Did Not Examine ☐ Abnormal Remarks:
Nervous System ☐ Normal ☐ Did Not Examine ☐ Abnormal Remarks:	Musculoskeletal ☒ Normal ☐ Did Not Examine ☐ Abnormal Remarks:
GI Tract/Abdomen ☐ Normal ☐ Did Not Examine ☐ Abnormal Remarks:	Cardiovascular ☒ Normal ☐ Did Not Examine ☐ Heart Murmur Grade ____/VI Murmur Comments: ☐ Abnormal Remarks:
Body Condition Score ☐ 1 ☐ 2 ☒ 3 ☐ 4 ☐ 5 1-Very Thin 3- Ideal 5-Obese	Urinary and Genitals ☒ Normal ☐ Did Not Examine ☐ Abnormal Remarks:
Assessment & Plan	
Assessment:	
Plan:	Needs another set of vaccines. Owner will update later

Figure 1: Physical exam sheet used to document study dog health prior to surgery



Figure 2: Attaching blood pressure, temperature, pulse oximetry, and ECG monitors to study dogs prior to surgery.

but respiration is regular and unassisted. This is the most common plane of surgical anesthesia used for procedures. Plane 3 is characterized by diminishing ability to breathe without assistance and shallow respiration. Plane 4 patients cannot breathe on their own and respiratory arrest is imminent. Finally, Stage 4 is an anesthetic crisis where respiratory and cardiac arrest commonly occurs.¹⁷ A good plane of anesthesia for study animals (Stage 3, plane 2) was defined as maintenance of a constant blood pressure, heart rate, respiratory rate, eye position (medioventral) and jaw tone (loose) during surgical manipulation of tissues.²

Statistical hypotheses were constructed based on the amount of isoflurane (% concentration) needed to maintain a good plane of anesthesia for a dog during surgery. Using the notations that: Ave^C = the mean isoflurane consumption within the Control group and Ave^T = the mean isoflurane consumption within the Treatment group; the study hypothesis was translated as the ratio of Ave^T to Ave^C (i.e., Ave^T/Ave^C) is not greater than 0.9 (i.e., Ave^T is at least 10% smaller than Ave^C). The statistical hypotheses (null and alternative) can be stated as $H_0: Ave^T/Ave^C \geq 0.9 + \xi$; $H_A: Ave^T/Ave^C < 0.9 + \xi$, where ξ is the non-inferiority parameter (that is, the maximal tolerance margin for claiming non-inferiority), which was set to be 5%.

The decision whether the null hypothesis could be rejected was based on the 95% confidence interval of ($Ave^T/Ave^C - 0.9$) constructed by the bootstrap method

(with 3000 bootstrap replicates). If the upper bound of the 95% confidence interval was smaller than the non-inferiority parameter 5%, then the null hypothesis could be rejected and the study hypothesis supported by the data.

Additional statistical inferences were carried out to compare subject characteristic data between control and treatment groups. These data included body weight, age, body temperature, and blood pressure, which could potentially confound the study outcome if a significant difference was found between the two subject groups. Since these were all continuous variables, two-sample t test was applied for these comparisons and $p < 0.05$ was considered statistically significant.

Sample size consideration was based on the author's experience that the concentration of isoflurane needed to maintain a good plane of anesthesia during canine orchiectomy is between 2.0 and 2.5%. Assuming that (1) the mean consumption in the control group is 2.25% with a standard deviation of 0.3%, and (2) the mean consumption in the treatment group is 80% (20% reduction) of that in the control group and based on a simulation study (1000 iterations) on bootstrap 95% confidence intervals; a sample size of at least 13 subjects in each group was required to achieve a 90% power to reject the null hypothesis with significance level = 0.05.

Table 1: LIV-3 acupoint, location, indications and actions.

Acupoint	Location	Attributes, Indications and Actions ¹
LIV-3	Between the 2 nd and 3 rd metatarsal bones proximal to the metatarsal-phalangeal joint	<i>Shu</i> -stream point, <i>Yuan</i> -source point, effective for <i>Qi</i> -Blood Stagnation and pain, Liver <i>Qi</i> Stagnation, paralysis of hind limbs



Figure 3: Inserting needle at acupoint LIV-3 while veterinary technician, who will monitor anesthesia, is out of surgery suite.



Figure 4: Covering the feet with pipe insulation to maintain blinding of veterinary technician, who will monitor isoflurane anesthesia use during surgery.



Figure 5: Veterinary technician monitoring anesthesia during surgical procedure.

Surgical Procedure Form Pet Info: Test Group: Study Animal #16 East Ridge Animal Hospital, Canine, Retriever, Labrador Mix, 7 Mos. 1 Wks. 0 Days, Male Date: Dr. Knarr Assistant: Angela														
Procedure Neuter				Anesthetic Risk Assessment 1 ☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ ☐ Emergency ☐		Pre-existing problems & possible complications:								
Drugs		Dose (mg)	Volume (ml)		Route	Time	Comments			IV Catheter ☐ Gauge: Vein:		IV Fluids ☐ Type: Rate: ml/hr		
Premedication										ET Tube Size: Anesthetic Circuit Non-Rebreather ☐ Rebreather ☒		Heating Pad ☒ Acupuncture Needles ☐		
Hydromorphone			2.8		SQ	10:00								
Induction										ET Tube Size: Anesthetic Circuit Non-Rebreather ☐ Rebreather ☒		Heating Pad ☒ Acupuncture Needles ☐		
Telazol			0.6		IV	11:15								
GAS ANESTHESIA		Isoflurane ☒		Sevoflurane ☐		Oxygen flow rate: ___ L/min		Vaporizer Settings						
Time	11:20	11:30	11:35											
8.0														
7.0														
6.0														
5.0														
4.0														
3.0														
2.0														
1.0														
0														
		x												
			1.5	1.0										
				x										
FLUIDS														
Time														
Rate														
Total														
Monitoring														
SPO2	95	93	95	99										
HR	120	108	98	100										
RR														
TEMP														
ETC														
O2														
BP (S/D)	120/60	115/50	110/40	110/40										
COMMENTS								Anesthesia Start Time: 11:15				Dr. K. Knarr		
								Anesthesia End Time: 11:35				Assistant: A. Hart		
								Surgery Start Time: 11:20						
								Surgery End Time: 11:35						
Comments: Additional medications, complications, etc. Had needles during sx														
Post Operative And Intra-Operative Medicines														
Drug		Dose/Dosage			Route			Frequency/Time						
Carprofen 100mg		100mg			po			PM						

Figure 6: Anesthetic and surgical monitoring sheet used for each study dog during the surgical procedure.

RESULTS

A total of 34 intact male canine patients were recruited from the three collaborating animal shelters and one animal hospital. The random assignment procedure resulted in 18 patients being assigned to the test group (with acupuncture) and 16 patients assigned to control group (no acupuncture). Two study dogs assigned to the acupuncture group (treatment group) were removed from the study after the surgical procedure was completed. Upon removal of the pipe insulation, it was noted that the acupuncture needles had moved from the site where they had been placed. The number of dogs completing the study was therefore decreased to 32 dogs; 16 control animals and 16 test animals.

The study author performed the surgical procedure on all animals and monitoring of plane of anesthesia and isoflurane usage was performed by the same technician. All dogs received 4 days of post-operative pain medications which included Vetprofen[®] (carprofen) at 4.4 mg/kg once daily (SID) or Meloxicam liquid^f 1.5mg/ml at 0.1mg/kg SID for dogs difficult to medicate and Galliprant[®] (gapiprant) at 2mg/kg SID was used for a 10-year-old dog.

There was a variety of dog breeds in the study with 12 mixed-breed dogs, 1 German Short-haired Pointer, 1 Pitbull, 1 Alaskan Huskey, and 1 Lhasa Apso in the treatment group. In the control group there were 11 mixed-breed dogs, 1 Toy Poodle, 1 Yorkshire Terrier, 1 Pitbull, and 1 Jack Russell terrier. Study dogs had a wide range of body weights and ages with no statistical difference found in mean body weight ($p=0.115$) or age ($p=0.376$) between dogs randomized to the control group and those to the treatment group that could potentially confound outcome of the study (Table 2). Similarly, body temperature for the two groups did not differ significantly ($p=0.08$) at study start. After surgery, however, the mean body temperature had a statistically significant decrease in both groups ($p = 7.09 \times 10^{-7}$ and 8.60×10^{-4}) for control and treatment, respectively; paired t test) but the difference in reduction was not statistically significant between study groups (2.08 ± 0.22 vs. 1.52 ± 0.35 ; $p=0.192$).

Comparison of mean systolic blood pressure prior to surgery was $117.56 (\pm 5.35)$ in the control group and 107.0

(± 4.47) in the treatment group, which was not statistically different between groups (p -value = 0.14, two-sample t test) (Table 2). After surgery, the mean systolic blood pressure in both groups increased: $128.75 (\pm 4.83)$ control group, and $107.69 (\pm 3.65)$ test group. The increase was statistically significant only in the control group ($p = 0.035$; paired t test).

Study outcome (amount of isoflurane in % concentration required to maintain a good plane of anesthesia during surgery) resulted in lower isoflurane usage ($<2.0\%$) until the end of surgery in all but 1 patient (#14) in the treatment group (93.75% incidence). Dog #14 was maintained at the same level of isoflurane concentration during the procedure. The treatment group also demonstrated a steady decrease in isoflurane use throughout the study in 13 out of 16 (81.25%) animals (Figure 7). In addition, 8 of 16 patients (50%) in the acupuncture group required lower isoflurane concentrations as early in the surgery as 3 minutes after insertion of the acupuncture needles.

All control group patients, with the exception of 3 dogs, were maintained at the same level of isoflurane concentration (2%) until the end of the surgery. Two (#1, #2) of these 3 dogs required higher concentrations of isoflurane and 1 dog (#13) was maintained on a lower concentration (6.25% incidence), (Figure 7). For statistical comparison between control and treatment groups, looking at proportion of subjects requiring lower anesthetic concentration during the surgery, a two-sample test for equality of proportions statistically confirmed a significantly higher proportion in the treatment group than in the control group ($p = 4.30 \times 10^{-6}$).

Quantitatively, the mean average isoflurane concentration required among dogs in the treatment group was 1.37% (+ or - 0.08) for maintenance of a good plane of anesthesia (Figure 8). The demanded concentration in the control group remained at 2% (2.01 ± 0.05). Comparison of the 2 groups yielded a 32% reduction in isoflurane usage by test dogs (Figure 8). Based on the bootstrap method (with 3,000 bootstrap replicates), the 95% BCa confidence interval of (AveT/AveC - 0.9) is (-0.299, -0.142), which has an upper bound smaller than

Table 2: Summary statistics (mean $\pm$ SD) of control and test group age, body weight, body temperature (before and after surgery) and blood pressure (before and after surgery).

		Control Group	Test Group	p-value
Age (months)		23.16 $\pm$ 3.41	30.63 $\pm$ 7.52	0.376
Body Weight (pounds)		31.74 $\pm$ 4.11	40.40 $\pm$ 3.40	0.115
Body Temperature (°F)	Before surgery	100.94 $\pm$ 0.17	100.36 $\pm$ 0.27	0.083
	After Surgery	98.86 $\pm$ 0.16	98.84 $\pm$ 0.39	0.957
Blood Pressure (systolic)	Before surgery	117.56 $\pm$ 5.35	107.0 $\pm$ 4.47	0.141
	After Surgery	128.75 $\pm$ 4.83	107.69 $\pm$ 3.65	0.002*

* $p < 0.05$, statistically significant

the non-inferiority parameter 5%. The null hypothesis, therefore, could be rejected. That is, the data observed from the study supported the hypothesis that the proposed acupuncture treatment can reduce the required isoflurane concentration during surgery by at least 10%.

DISCUSSION

This is the first randomized, controlled study demonstrating reduced anesthetic use associated with stimulation of LIV-3 acupoint during orchiectomy surgery in dogs. Out of a total of 32 study dogs, the 16 dogs that received acupuncture during surgery needed, on average, 32% less isoflurane gas anesthesia to maintain a good plane of anesthesia when compared to the 16 dogs that did not receive acupuncture. The results of the study supported the hypothesis that the integration of dry needle

acupuncture during a conventional surgical anesthetic protocol would decrease the dose of inhalation anesthetic (isoflurane) needed to maintain a good plane of anesthesia by at least 10%.

With respect to the proportion of patients requiring less anesthesia, 93.75% (15/16) of the dogs in the test group received lower amounts of anesthesia during surgery while maintaining a good plane of anesthesia whereas this was true for only 6% of the dogs in the control group (1/16). In addition, 50% of the dogs in the test group had a lower amount of anesthesia needed as early as 3 minutes after needle insertion before the surgical procedure started.

Comparison of mean systolic blood pressure prior to surgery between the control group and test group was not statistically different between groups. After surgery, however, the mean systolic blood pressure in both groups

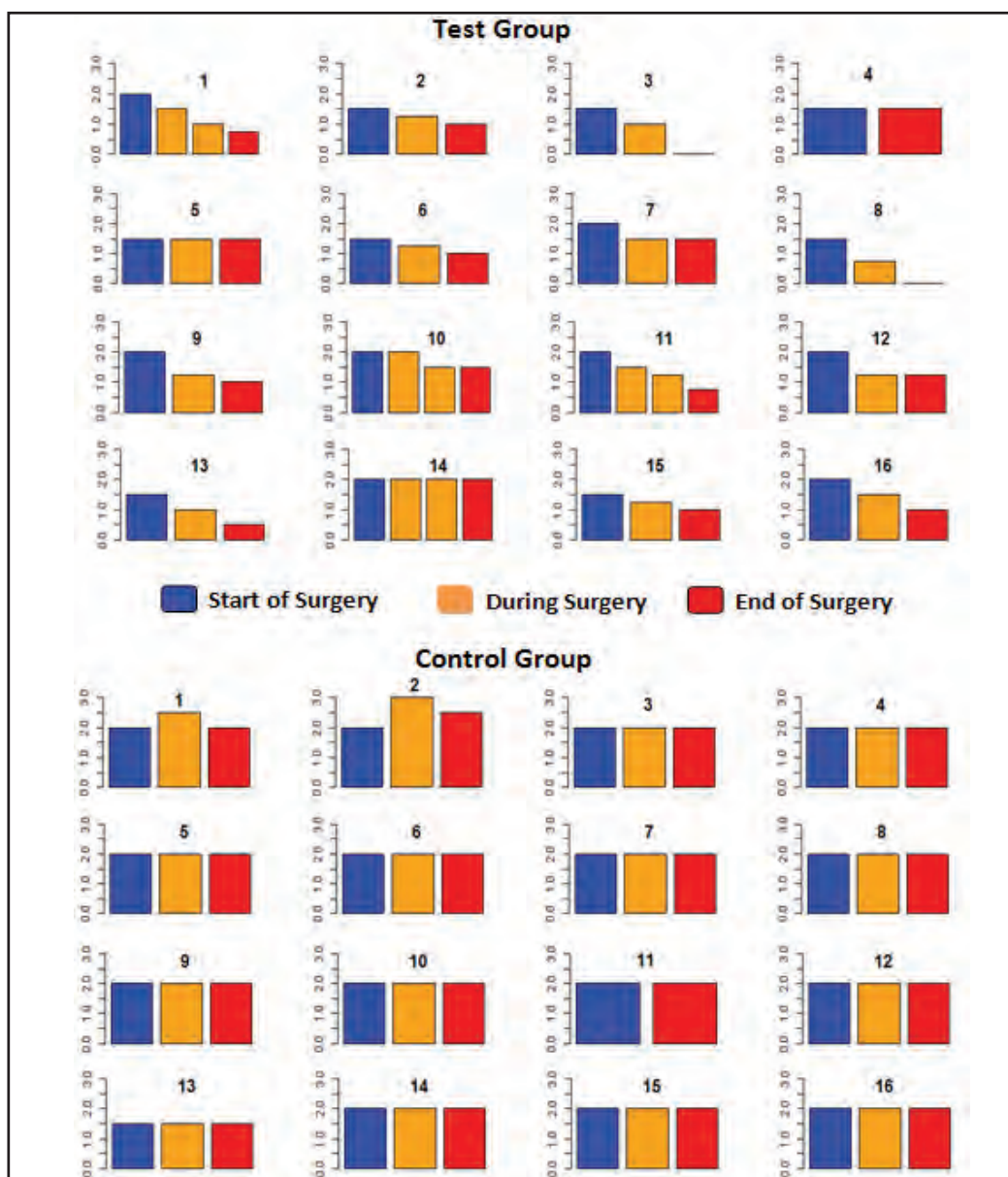


Figure 7: Isoflurane concentration readings of each patient in Test (top) or Control group.

increased: $128.75 (\pm 4.83)$ control group and $107.69 (\pm 3.65)$ test group. The increase was statistically significant only in the control group ($p = 0.035$; paired t test). The lack of a significant change in blood pressure during surgery in the test group demonstrated improved blood pressure stability in this group associated with LIV-3 stimulation.

There has been a large body of work reported in the scientific literature over the last 20 years explaining the physiologic effects of acupuncture. Beneficial effects, particularly regarding support of surgical procedures include improved vasodilation, improved immune response, release of natural endorphins and analgesic segmental effects on the spinal cord.^{6, 18, 19}

Similar to the present study, Jeong and Loret reported decreased anesthetic requirements associated with acupuncture use during canine surgical procedures. Jeong demonstrated significantly ($p < 0.05$) lowered mean alveolar concentration of isoflurane in dogs after electro-acupuncture (EAP) of 4 acupoints for 30 minutes when compared to the control group or non-acupoint stimulation. In addition, stimulation of specific acupuncture points was associated with decreased mean and diastolic arterial pressure, and decreased systemic vascular resistance while other acupoints had no effect. The author reported these results indicate that EAP at LI-4, SP-6 and ST-36 have advantages for isoflurane anesthesia in terms of reducing the dose of anesthetics and minimizing cardiovascular side effects.²⁰

Lloret documented the successful use of EAP before and during surgery for dentistry, orchiectomy, ovariectomy, and skin mass removal in dogs. It was concluded that EAP for 10-40 minutes pre-surgery and during the procedure would lower the amount of

intramuscular sedation and IV anesthesia that was used and provided improved post-surgical pain relief. In addition, with EAP use, inhalation anesthesia was not necessary for the simple procedures evaluated in this study. It is interesting to note that one of the acupoints used during canine orchiectomy in this group of dogs was LIV-3.²¹

Several studies, all using LIV-3 as one of the acupoints, investigated blood pressure effects associated with acupuncture therapy in clinical studies using human hypertensive subjects.²²⁻²⁴ All 3 studies demonstrated statistically significant ($p < 0.05$) decreases in blood pressure measurements (systolic and/or diastolic) in subjects after several treatments. Severcan's study also demonstrated an improved nitric oxide (NO) effect. The NO concentration increased both after the 1st acupuncture session as well as the 10th session ($p < 0.05$).²⁴

Clinical studies in humans and dogs have been conducted evaluating pain relief and beneficial effects on other disease syndromes with LIV-3 included as one of the acupuncture points. These include pain relief of migraine headaches, painful scar tissue, nocturia symptoms, reduction of intraocular pressure, successful use in glaucoma studies and as adjunctive pain relief when combined with standard anesthesia in select human surgical procedures.²⁵⁻³²

Descriptions of cerebral neural effects of the LIV-3 acupuncture point have been investigated. Microarray (miRNA) analysis (noncoding RNAs playing important roles in many biological processes) was performed to compare the miRNA expression profiles of the medulla in spontaneous hypertensive rats treated with or without stimulation of LIV-3 (*taichong*) acupoint. Among the miRNAs (222 differentially expressed), there were 23

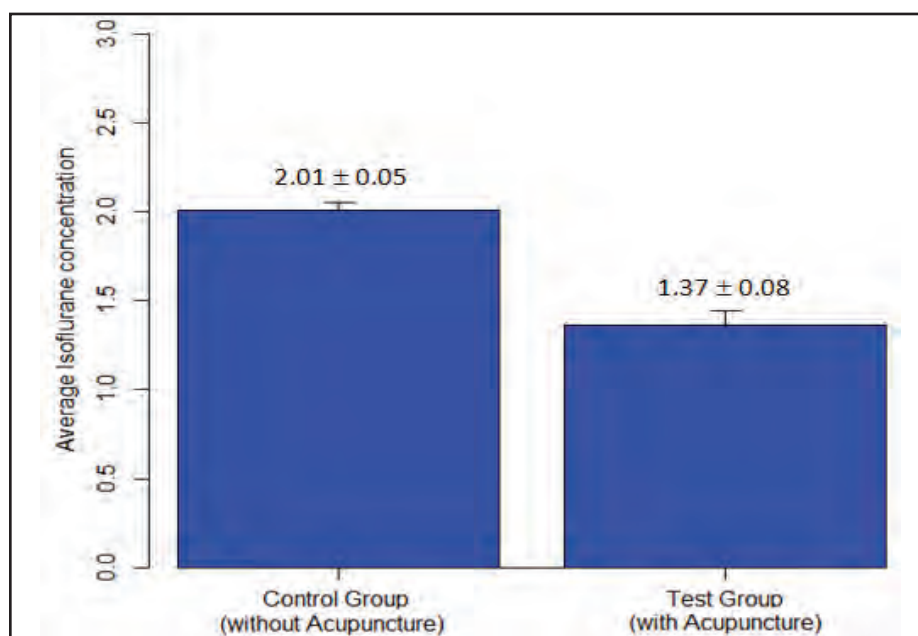


Figure 8: Comparison of mean average isoflurane concentration readings between Control Group and Test Group. There was a 32% reduction in isoflurane usage in the study dogs treated with acupuncture prior to the surgical procedure.

with a significant difference between LIV-3 treated rats compared to untreated (downregulated in hypertensive rats and upregulated back to normal after acupuncture). These 23 miRNAs could regulate 2963 target genes which were enriched in at least 14 pathways. Results from this study provided insights into how this acupoint elicits beneficial effects on hypertension.³³

Another mechanistic study conducted by Liu investigated the activity of LIV-3 on brain visual cortex and evidence of efficacy for treating ophthalmic diseases.³⁴ Thirty healthy adult volunteers were divided into 2 groups with half receiving EAP at LIV-3 and the other half stimulated at a sham acupoint near LIV-3. The study found that EAP at LIV-3 activated the left lingual gyrus and right inferior occipital gyrus, bilateral angular gyrus, bilateral medial frontal gyrus, bilateral inferior gyrus, left superior temporal gyrus, left inferior temporal gyrus, and right supramarginal gyrus. Sham EAP only activated the left precentral gyrus. Their study findings supported LIV-3 acupoint efficacy for the treatment of ophthalmic diseases. Their study also suggested LIV-3 stimulation treats depression and aphasia by activating regional cerebral limbic areas and the language system.³⁴ In another human study, a Chinese-German single-blinded experimental trial evaluated acupuncture at LIV-3 and GB-40 and demonstrated activation of the secondary somatosensory cortical areas, frontal areas, the right side of the thalamus and the left side of the cerebellum. Sham-points had no effect.³⁵

Limitations to this study included variability of study dog breeds, housing, diet and behavioral environment. The ideal study would use similar sized dogs of the same breed, housed in 1 location on similar diets. To overcome these limitations and produce valid study results, the following methods were used: randomization of study animals, control group use, blinding of the technician evaluating isoflurane use and adequate sample size (13 animals/group) determined by statistical calculation.

In summary, there were no adverse effects associated with dry needle insertion at LIV-3 in test group dogs and the use of this acupoint provided statistically significant decreases in the amount of isoflurane anesthesia (32%) needed during a urogenital surgical procedure. Furthermore, dry needle insertion at LIV-3, which remained in place during surgery provided statistically significant blood pressure stabilization during the procedure when compared to control group dogs. The use of LIV-3 provides an effective, simple, low cost procedure for clinicians to use as an adjunct to normal anesthesia in urogenital or abdominal surgeries. Its use provides additional pain relief during surgery accompanied by decreased isoflurane gas anesthesia usage to maintain a good plane of anesthesia along with improved cardiac stabilization. Future basic research studies with an emphasis on underlying mechanisms of acupoint activity, such as LIV-3, would allow more targeted clinical studies and would provide additional information on optimizing

the use of acupuncture as an adjunct to surgical procedures.

ACKNOWLEDGEMENTS

The author would like to thank East Ridge Animal Services, Walker County Animal Shelter, the Humane Educational Society of Chattanooga and the clients of East Ridge Animal Hospital for allowing surgical participation of their animals and use of their anesthetic values in this study. The author also wishes to thank veterinary technicians, Angela Middleton Hart for monitoring surgical anesthesia and Crystal Fulton for surgical preparation of study dogs. Appreciation is also extended to the author's Master's Committee, Dr. Deng-Shan Shiao for his help, support, patience and statistical expertise; Dr Aituan Ma for her help and support; and Dr Huisheng Xie for his wonderful mentoring and inspiration in learning TCVM. Finally, a special thank you to the staff of East Ridge Animal Hospital for all their help, scheduling and support of this study.

FOOTNOTES

- a. Morphine Sulfate 10mg/ml), West-ward, Eatontown, NJ, USA.
- b. Telazol (tiletamine HCL, zolazepam HCL) Zoetis Inc., Kalamazoo MI. Made in Spain.
- c. Isoflurane Anesthesia Piramal Enterprise Limited, Andhra Pradesh, India.
- d. Jing Mei copper needles Distributed by Dr. Xie's Jing Tang Herbal, Inc., Reddick, FL, USA.
- e. Vetprofen (carprofen) Belcher Pharmaceuticals, LLC, Largo, FL, USA.
- f. Meloxidyl (meloxicam oral suspension 1.5mg/ml) Patterson Veterinary, Greeley, CO, USA.
- g. Galliprant (grapiprant) Aratana Therapeutics, Leawood, KS. Made in New Zealand.

REFERENCES

1. Bednarski R, Grimm K, Harvey R et al. AAHA Anesthesia Guidelines for Dogs and Cats. JAAHA 2011; 47(6):377-385.
2. Lee L. Anesthetic monitoring. Lecture 12 Center for Veterinary Health Services, Oklahoma State University 2007; <https://instruction.cvh.s.okstate.edu/vmed5412/lect012.htm>.
3. Hughes J. Anesthesia for the geriatric dog and cat. Irish Veterinary Journal 2008; 61(6): 380-387.
4. Bille C, Auvigne V, Libermann S, et al. Risk of anaesthetic mortality in dogs and cats: an observational cohort study of 3546 cases. Veterinary Anesthesia and Analgesia 2012; 39(1):59- 68.
5. Chi Institute of Traditional Chinese Veterinary Medicine. What is traditional Chinese veterinary medicine?. Chi Institute of Traditional Chinese Veterinary Medicine website 2017: www.tcvm.com/About/WhatisTCVM.aspx.
6. Skorupska E, Rychlik M, Pawelec W, et al. Dry needling related short-term vasodilation in chronic

- sciatica under infrared thermovision. Evidence Based Complementary Alternative Medicine 2015;article ID 214374:10 pages.
7. Zhang W, Ahang Y, Ma S, et al. Effects of acupuncturing Pishu combined with Ginsenoside Rg3 on the immune function of rats with chronic fatigue. *Int. J. Clin. Exp. Med.* 2015;8(10): 19022-19029.
 8. Gropetti D, Pecile A, Sacerdote P, et al. Effectiveness of electroacupuncture analgesia compared w/opioid administration in a dog model: a pilot study. *Br. J. Anaesthesia* 2011; 107 (4): 612-618.
 9. Baemur P, Fleckenstein J, Benedikt F, et al. Acupuncture -induced changes of pressure pain threshold are mediated by segmental inhibition. A randomized controlled trial. *Pain* 2015; 135(11): 2245-2255.
 10. Jie W, Fang X, Pu R, et al. Analgesic effect of buccal acupuncture on acute arthritis in rabbits and underlying mechanisms. *Shong Nan Da Xue Xue Bao Yi Yue Ban.* 2017;42 (5): 517-521.
 11. Shin J, Lee Y, Kim M, et al. Long-term course of alternative and integrative therapy for lumbar disc herniation and risk factors for surgery: A prospective observational 5-year follow-up study. *Spine* 2016; 41(16): 955-963.
 12. Zhu X, Liu Z, Niu W, et al. Effects of electroacupuncture at ST25 and BL25 in a Sennae-induced rat model of diarrhoea-predominant irritable bowel syndrome. *Acupunct Med.* 2017; (3): 216-223.
 13. Xie H, Preast V. Xie's Veterinary Acupuncture. Ames, IA: Blackwell Publishing 2007: 16, 190.
 14. Yin C, Buckheit TE, Park J. Acupuncture for chronic pain: an update and critical overview. *Curr Opin Anaesthesiol* 2017; 30(5): 583-592.
 15. Newberry S, Blinn M, Bushby P et al. Guidelines for Standards of Care in Animal Shelters. The Association of Shelter Veterinarians 2010.
 16. Stein R. Canine anesthetic protocols. Veterinary Anesthesia and Analgesia Support Group April 9, 2011. www.vasg.org/preanesthetic.
 17. Richards M. Anesthesia. *Vetinfo*. <https://www.vetinfo.com/danesth.html>.
 18. Tedesco D, Gori D, Desai K, et al. Drug-free interventions to reduce pain of opioid consumption after total knee arthroplasty: A systemic review and metanalysis. *JAMA Surg* 2017; 152(10): edoc 172872.
 19. Liu J, Chen S, Gao Y, et al. Effects of repeated electroacupuncture on beta-endorphin and adrenocorticotrophic hormone levels in the hypothalamus and pituitary in rats with chronic pain and ovariectomy. *Chin J Integr Med* 2010; 16(4): 315-323.
 20. Jeong S, Nam T. Effect of electroacupuncture on minimum alveolar concentration of isoflurane in dogs. *J Vet Med Sci* 2003; 65 (1): 145-7.
 21. Lloret L. Use of electro-acupuncture anesthesia and analgesia in minor veterinary surgical procedures. *AJTCVM* 2015;10(2): 69-73.
 22. Williams T, Mueller K, Cornwall M. Effect of acupuncture-point stimulation on diastolic blood pressure in hypertensive subjects: A preliminary study. *Physical therapy* 1991;71(7): 523-529.
 23. Cevik C, Iseri S. The effect of acupuncture on high blood pressure of patients using antihypertensive drugs. *Acupunct Electrother Res* 2013;38(1-2):1-15.
 24. Severcan C, Cevik C, Acar H, et al. The effects of acupuncture on the levels of blood pressure and nitric oxide in hypertensive patients. *Acupunct Electrother Res* 2012;37(4):263-275.
 25. Allais G, Delorenzo C, Quirico P, et al. Acupuncture in the prophylactic treatment of migraine without aura: a comparison with flunarizine. *Headache* 2002;42(9): 855-61.
 26. Allais G, Delorenzo C, Quirico P, et al. Non-pharmacological approaches to chronic headaches; transcutaneous electrical nerve stimulation, lasertherapy and acupuncture in transformed migraine treatment. *Neurol Sci* 2003; 24:138-42.
 27. Lee H, Ernst E. Acupuncture analgesia during surgery: a systematic review. *Pain* 2005; 114(3): 511-517.
 28. Uhrig S, Hummelsberger J, Brinkhaus B. Standardized acupuncture therapy in patients with ocular hypertension or glaucoma; results of a prospective observation study. *Forsch Komplementarmed Klass Naturheilkd* 2003; 10(5):256-261.
 29. Fang S. The successful treatment of pain associated with scar tissue using acupuncture. *J Acupunct Meridian Stud* 2014;7(5):262-264.
 30. Cevik C, Iseri S. Treatment of nocturia symptoms with acupuncture. *Acupunct Electrother Res* 2013;38(3-4):199-210.
 31. Kim M, Yoo J, Seo K, et al. Effects of electroacupuncture on intraocular pressure and hemodynamic parameters in isoflurane anesthetized dogs. *J Vet Med Sci* 2007; 69(11):1163-1165.
 32. Kim M, Seo K, Nam T. Effect of acupuncture on intraocular pressure in normal dogs. *J Vet Med Sci* 2005; 67(12):1281-1282.
 33. Wang J, Li H, Ma C, et al. MicroRNA profiling response to acupuncture therapy in spontaneously hypertensive rats. *Evid Based Complement Alternat Med* 2015; edoc 204367.
 34. Liu Y. Observation of the brain visual cortex activation on MRI by electroacupuncture stimulation at LIV-3 (tai chong). Fujian Medical University 2009; Master Thesis.
 35. Fang J, Krings T, Weidemann J, et al. Functional MRI in healthy subjects during acupuncture: different effects of needle rotation in real and false acupoints. *Neuroradiology* 2004; 46:359-362.