Modulatory Effect of Electroacupuncture on Isoflurane Anaesthesia in Cats

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Abstract

This study aimed to evaluate the combination of electroacupuncture (EA) and isoflurane as an anesthetic regimen in domestic cats. A total of 15 cats were divided into two groups, namely tiletamine-zolazepam (TZ) (n = 5) and EA (n = 10). Atropine was used as a premedication, injected 5 min before the induction of TZ. Approximately 10 min after induction, endotracheal intubation was applied, and cats were connected to isoflurane anesthesia. EA was applied to the EA group during the first 10 min of the total 30 min under isoflurane maintenance. Furthermore, the acupuncture points ST-36 and SP-6 were used at a frequency of 80 Hz and an intensity of 4 mA. The quality of anesthesia was evaluated by several parameters, including isoflurane requirements, anesthesia quality, cardiovascular function, and respiratory function. Data were collected every 10 min for a total of 30 min from the time of isoflurane application, followed by analysis using a t-test with Welch's correction. The results showed that there was a significant reduction in isoflurane requirement in EA group, as indicated by the area under the curve (AUC) (p = 0.0003). Isoflurane concentration at 10 min was significantly lower in EA group (1.25 ± 0.71) than in TZ group (2.1 ± 0.22). It was also significantly lower at 20 min in EA group (1.05 ± 0.79) than in TZ group (1.8 ± 0.27). In conclusion, the addition of EA effectively reduced isoflurane requirements while maintaining a similar quality and safety of anesthesia in both groups.

Keywords: anesthetic effect, electroacupuncture, isoflurane, tiletamine-zolazepam

Received: February 26, 2025 **Revised:** May 21, 2025 **Accepted:** July 17, 2025

INTRODUCTION

A balanced combination of anesthetic agents is necessary to achieve the desired result with minimal side effects. Isoflurane is a volatile anesthetic commonly used in veterinary practice in Indonesia. In a study by Khalifah *et al*. (2024), the use of isoflurane in small animal practices in Jakarta and West Java Provinces reached 43.5%. Isoflurane is recognized for the safety and neuroprotective properties in brain tissue (Chen *et al.*, 2022). The quantity required to maintain anesthesia is affected by pre-anesthetic agents. Therefore, combining multiple anesthetics helps achieve balanced anesthesia.

Contemporary trends in the field of anesthesia include the use of multiple drugs that have selective and complementary actions. Balanced anesthesia is a method of achieving various components through the use of smaller doses of combined drugs. This approach is intended to mitigate the disadvantages associated with the use of large drug doses (Novakopski *et al.*, 2016).

In 1958, acupuncture was used alongside anesthesia to manage pain during surgery (Wei and Qiang, 2019). As a non-pharmacological therapy, acupuncture modulates anesthesia by enhancing perioperative analgesia and reducing the need for anesthetics as well as opioids in small animals (Bacarin *et al*., 2022). However, the single application is insufficient to ensure an adequate anesthetic effect in surgical procedures (Lu *et al*., 2015). Acupuncture cannot replace anesthetic agents. Lu *et al*. (2015) proposed the concept of "acupuncture drug balanced anesthesia". This concept refers to the use of acupuncture and drug binding to manage patients during the perioperative period. Several studies have shown the potential of acupuncture to modulate perioperative anesthetic conditions to improve balanced anesthesia.

Numerous studies have been conducted to combine acupuncture and anesthetic agents, but

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the results have been inconclusive. Bacarin *et al.* (2022) mentioned that not all dissociative anesthetics have synergistic effects with acupuncture. Jeong and Nam (2002) also found that electroacupuncture (EA) reduced isoflurane requirements in dogs. Furthermore, Lin *et al*. (2010) demonstrated acupuncture ability to shorten recovery time and alleviate the negative physiological effects of anesthesia on the heart when combined with ketamine-xylazine. Ingerson (2023) reported no significant difference in recovery time when atipamezole and acupuncture were combined during ovariohysterectomy in cats, except in the acupuncture-only group, which required longer recovery. Hammond (2023) also found that intraoperative EA did not significantly reduce isoflurane requirements in dogs undergoing ovariohysterectomy.

The inconclusive results concerning the efficacy of acupuncture in enhancing the quality of anesthesia in small animals can be ascribed to various factors. These include the employed protocol, selection of study animals, and patient background. Specialized studies in specific animals are important because of the important differences in physiological responses (Rahmiati *et al*., 2025). In Indonesia, acupuncture is used in a modest capacity as a component of animal physiotherapy, but the application in balanced anesthesia for domestic cats has not been documented. Therefore, this study aimed to evaluate the combination of EA and isoflurane as an anesthetic regimen in domestic cats.

MATERIALS AND METHODS

Ethical Approval

This study was granted ethical approval with the approval number 181/KEH/SKE/II/24 from the Animal Ethics Committee, School of Veterinary Medicine and Biomedical Sciences, IPB University.

Study Period and Location

This study was conducted from February to July 2024. The collected data included both qualitative and quantitative data on anesthetic effects observed in the experimental cats. Anesthesia procedures, data collection, and analysis were performed at the Small Animal Surgery Laboratory, School of Veterinary Medicine and Biomedical Sciences, IPB University. Meanwhile, blood tests were performed at the Veterinary Hospital, IPB University.

Experimental Animals

A total of 15 domestic cats were divided into 2 treatment groups, namely tiletamine-zolazepam (TZ) and isoflurane maintenance, as well as anesthetic protocol with the addition of EA. TZ group consisted of 5 cats, and EA group consisted of 10 cats. The inclusion criteria for cats include domestic male and female aged 7 months to 2 years, weighing 3.5 ± 0.35 kg, non-pregnant, and considered healthy based on blood tests and clinical condition. Blood test criteria included white blood cells (WBC), red blood cells (RBC), platelets, albumin, globulin, and A/G ratio. A healthy condition was determined based on the clinical examination. Meanwhile, cats with respiratory, gastrointestinal, and other clinical signs of disease were excluded. Cats were subjected to a 7-day acclimatization period in a single cage and fasted for 8 h before anesthesia procedure. In general, fasting by restricting food intake affects bowel movements (Siswandi *et al*., 2019). During the acclimatization period, cats were given deworming medication (Drontal® Cat, Bayer, Germany) 1 tablet for 4 kg BW, flea treatment (Frontline® Plus Cats, Boehringer Ingelheim Animal Health, Germany) 1 tube for adult cats, and the same standard diet (Cat Choize, Perfect Comanion Group, Thailand) twice a day.

Anaesthesia Procedure

Atropine (V-Tropin® 0.3%, VTR-Bio Tech, China) was administered subcutaneously at 0.02 mg/kg body weight (BW) 5 min before anesthetic injection. Subsequently, anesthesia induction was achieved with intramuscular injection of TZ (Zoletil® 50, Virbac, China) at 5.3–10.6 mg/kg BW in the lumbar epaxial muscle. Endotracheal tube (ETT) intubation was performed 10 min later. Cats were then placed in dorsal recumbency and connected to a calibrated capnograph and inhalation anesthesia machine. The initial isoflurane concentration was determined using ETT intubation score as described by Grint *et al*. (2009). When the sedation score during intubation was >11, cats received 2% initial isoflurane concentration (Isoflurane®, Piramal Critical Care, India). Meanwhile, cats with sedation scores <11 received an initial isoflurane concentration of 3%.

Electroacupuncture Administration

EA was only administered in EA group and the acupuncture stimulation points used in this study followed the methods of Zu San Li (ST-36) and San Yin Jiao (SP-6) (Figure 1) (Nascimento *et al*., 2019). ST-36 acupuncture point is situated 3–6 cm distal to the lateral side of *caput fibulae*, on the lateral aspect of the distal border of the *cranial tibial tuberosity*, approximately in the center of the cranial tibialis muscle. Meanwhile, SP-6 acupuncture point is found 3–6 cm above the medial malleolus, along the back edge of the tibia, near the medial saphenous vein. The acupuncture needle used at ST-36 point was 0.25x25 mm, while the needle at SP-6 point was 0.20 × 13 mm. EA was applied for 10 min post-intubation using an electrostimulator (KWD-808 I, Ying Di, China) connected to needles (Suzhou Huanqiu, China) at ST-36 and SP-6 points previously exposed to an alcohol swab. EA was administered at a high frequency of 80 Hz and medium-high intensity of 4 mA. During EA administration, the needles remained at the appropriate point, and regular foot twitches were maintained in the session.

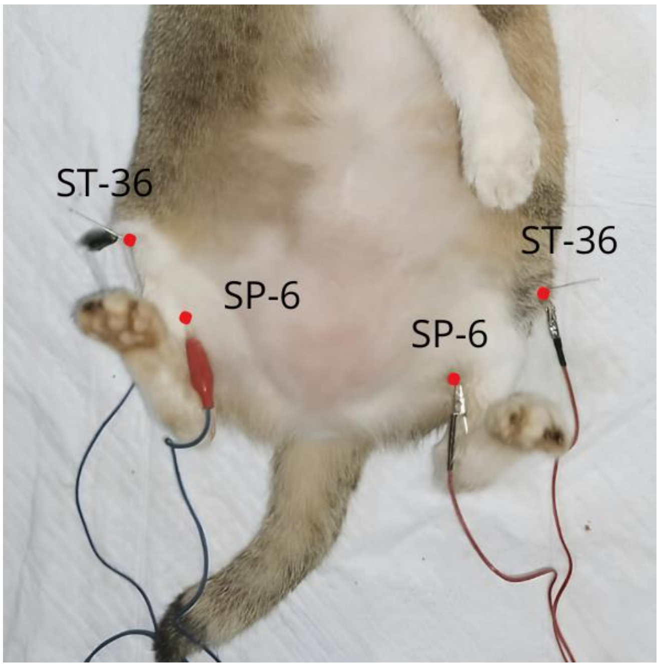

Figure 1. ST-36 and SP-6 acupuncture points in domestic cats.

Evaluation of Anaesthetic Quality

The quality of anesthesia was evaluated by several parameters, including isoflurane requirements, anesthesia quality, cardiovascular function, and respiratory function. These parameters were evaluated after isoflurane was successfully connected to cats and defined as 0 min. Evaluations were continued every 10 min until 30 min after isoflurane connection. Both groups were connected to isoflurane for 30 min and then discontinued, followed by ETT extubation. Recovery time was recorded from extubation to the onset of ambulatory behavior.

Isoflurane requirements for maintenance were determined using the Eger method of tail clamping with hemostatic forceps (Eger, 1984; Jeong and Nam, 2002). The tail was clamped for up to 1 min, and responses such as head elevation, foot lift, and tongue movement were observed. When no response was observed, isoflurane was

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maintained, and when all three responses were observed, the dose was increased by 1%. However, when only one or two responses were found, the dose of isoflurane was increased by 0.5%. In cases where no responses were observed during tail clamping, the administered isoflurane was reduced by 1%. Isoflurane consumption was recorded at 0', 10', 20', and 30 min post-intubation, then the sedation score was reassessed during extubation.

A sphygmomanometer (Contec08A-VET, Contec Medical Systems, China) was used to assess the heart rate, blood pressure, and oxygen saturation (SpO2) on the left forelimb. A SpO_2 sensor was attached to the right forepaw. Furthermore, respiratory rate was monitored using a capnograph (CA10M Contec Medical Systems, China), and body temperature was measured rectally. Physiological data were recorded at 0', 10', 20', and 30' min post-intubation. Electrocardiograms (ECG) were recorded immediately before intubation and after extubation using five electrode clips with sites cleaned by electrode gel or 70% alcohol. Intraocular pressure (IOP) was measured using a Schiotz tonometer immediately before intubation and after extubation.

Data Analysis

Significant differences among the groups were examined using a t-test with Welch's adjustment, applying a significance threshold of 5% ($p < 0.05$). The analysis was carried out using Prism version 10.4.0 (GraphPad Software, Inc., CA, USA).

RESULTS AND DISCUSSION

Hematological variables, including serum albumin and globulin levels, were measured in all cats, but no significant differences were found between the two groups. The mean body weight of TZ group was 3.3 ± 0.79 kg, while that of EA group averaged 3.44 ± 0.7 kg, with no statistically significant differences. These results confirm that both groups were comparable and homogeneous.

The maintenance concentration of isoflurane ranged from 1% to 5%, with an initial administration of 2%–3%. The results showed a significant difference between EA and TZ groups at 10 and 20 min of observation (Figure 2A). However, no significant differences were observed at 0 or 30 min. Isoflurane concentration at 10 min was significantly lower in EA group (1.25 ± 0.71) than in TZ (2.1 ± 0.22), and at 20 min in EA group (1.05 ± 0.79) compared to TZ (1.8 ± 0.27). A comparison of the calculated area under the curve (AUC) showed a significant difference (p = 0.0003) between TZ (60.00 ± 6.072) and EA groups (39.70 ± 9.264) (Figure 2B).

By lowering isoflurane requirement during maintenance, the results demonstrate the potential of combining EA and anesthesia to maximize anesthetic efficacy of isoflurane. This evidence was supported by t-test results from two different approaches, namely AUC calculations and time-dependent isoflurane requirement analysis.

Previous studies conducted by Jeong and Nam (2002) on dogs reported that the application of EA could reduce the minimum alveolar concentration (MAC) of isoflurane. Additionally, studies by Culp *et al*. (2005) on Beagle dogs showed a reduction in isoflurane MAC through the combination of EA and acepromazine-benzodiazepine induction. Wang *et al*. (2024) further reported that EA reduced intraoperative opioid consumption and minimized postoperative side effects following sinusotomy.

In this study, the use of high-frequency EA combined with TZ anesthesia successfully enhanced anesthetic effects of isoflurane in cats during the first 10 min post-intervention. The mechanism underlying this phenomenon is likely explained by Cassu *et al.* (2012), who reported that high-frequency EA induces the release of endogenous morphines (dynorphins) from the spinal cord. Groppetti *et al*. (2011) described the regulation of nociception induced by the application of EA. The neurohumoral mechanism explains how EA activates the periaqueductal gray (PAG) in the ventrolateral column, enhancing the release of endorphins in animals (agonists of κ and μ opioid receptors), thereby inducing the neuropeptides arginine vasopressin (AVP) and oxytocin. The neuromechanical mechanism underscores the ability of EA to suppress pain perception by increasing the immunoreactivity of substance P. Both mechanisms contribute to the regulation of nociception following EA treatment in cats.

The results showed no significant difference in the rate of body temperature decline between the two groups in anesthetic procedure. Statistical analysis using the t-test yielded non-significant outcomes at all observation times. Furthermore, AUC calculation demonstrated no statistically significant discrepancy between TZ (1125 ± 7.06) and EA groups (1120 ± 6.5). These results suggest that anesthetic method incorporating acupuncture modulation did not sufficiently affect the rate of temperature decline in treated cats. There are three phases of body temperature change during anesthesia, as described by Novakopski *et al.* (2016). In the first and second phases, animals experienced a continuous drop in body temperature lasting up to 3 hours. This is followed by a return to normal body temperature, which occurs over approximately 4 hours in the third phase. In the observation period, cats' body temperature continued to decrease (phases 1–2) under anesthetic effect.

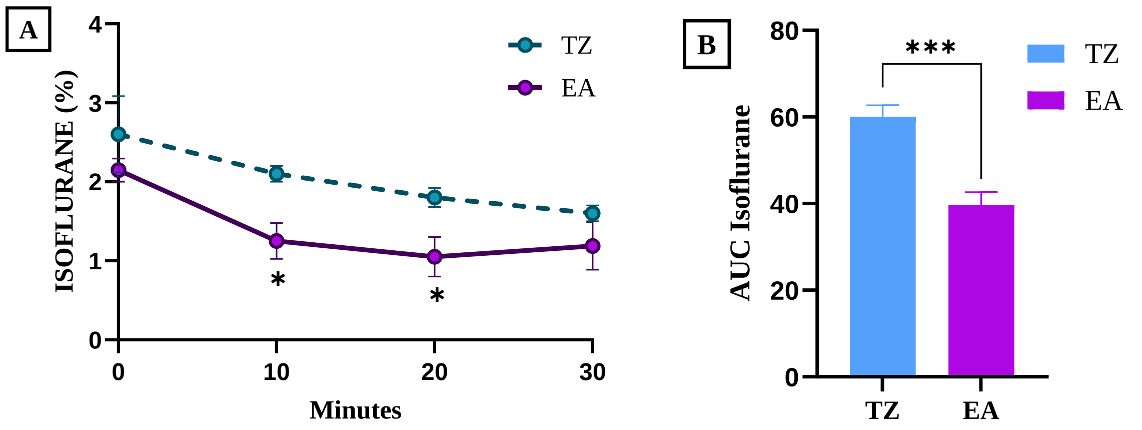

Figure 2. Graph of isoflurane concentration (A) and calculation of the area under curve (AUC) (B) for isoflurane concentration in both groups. Data are presented as mean ± SE at each observation time point. TZ (n = 5); EA (n = 10). ($^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$).

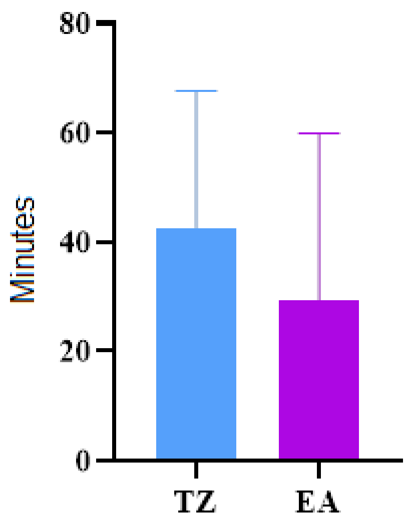

Figure 3. The average recovery time from anesthesia for both treatment groups is presented as mean ± SE. TZ (n = 5); EA (n = 10). No significant differences were observed.

Table 1. Sedation scores description for TZ group (n = 5) and EA group (n = 10)

Variable	Mean ± SD TZ	Mean ± SD EA	*p*-value
Intubation	10.4 ± 1.34	11.1 ± 1.37	0.3711
Extubation	7.6 ± 1.52	7.1 ± 2.42	0.6340

SD = Standard Deviation, TZ = Tiletamine-Zolazepam, EA = Electroacupuncture. ($^{*}p < 0.05$).

Table 2. Blood pressure in cats of TZ (n = 5) and EA (n = 10) groups

Variable	Time	Mean ± SD TZ	Mean ± SD EA	*p*-value
SAP (mmHg)	0’	108.4 ± 53.85	131.9 ± 29.99	0.3710
	10’	128.2 ± 29.12	120.4 ± 25.92	0.6983
	20’	137.6 ± 31.41	144.3 ± 52.8	0.9530
	30’	139 ± 41.5	164.9 ± 40.08	0.3097
DAP (mmHg)	0’	52.4 ± 20.03	72.4 ± 27.57	0.2168
	10’	69.2 ± 19.83	64.4 ± 26.76	0.5721
	20’	87.6 ± 40.44	65.4 ± 22.61	0.2960
	30’	96.4 ± 36.49	87.9 ± 24.96	0.9530
MAP (mmHg)	0’	71 ± 30.76	92.1 ± 27.22	0.1369
	10’	88.8 ± 15.27	82.9 ± 24.02	0.5678
	20’	104.2 ± 31.46	91.7 ± 31.81	0.3233
	30’	110.8 ± 34.09	120.9 ± 42.42	0.7679

SD = Standard Deviation, TZ = Tiletamine-Zolazepam, EA = Electroacupuncture, SAP = Systolic Arterial Pressure, DAP = Diastolic Arterial Pressure, MAP = Mean Arterial Pressure. ($^{*}p < 0.05$).

Table 3. Electrocardiogram recordings in cats of TZ (n = 5) and EA (n = 10) groups

Variable	Category	Mean ± SD TZ	Mean ± SD EA	*p*-value
PR Int (ms)	Intubation	64.8 ± 23.86	73.4 ± 36.75	0.5959
	Extubation	98.8 ± 25.16	78.9 ± 23.84	0.1814
P Int (ms)	Intubation	60.8 ± 19.37	53.8 ± 21.1	0.5381
	Extubation	75.4 ± 31.48	55.5 ± 22.22	0.2523
QRS Int (ms)	Intubation	167.0 ± 79.77	158.4 ± 74.87	0.8460
	Extubation	162.2 ± 93.65	130.2 ± 46.18	0.5030
T Int (ms)	Intubation	34.8 ± 5.54	35.9 ± 5.52	0.7261
	Extubation	35.4 ± 6.54	36.5 ± 10.96	0.8123

SD = Standard Deviation, TZ = Tiletamine-Zolazepam, EA = Electroacupuncture. ($^{*}p < 0.05$).

Sedation scores were evaluated during intubation and extubation. The responses shown by the experimental cats reflect the depth and the synergy of anesthesia methods used (Grint *et al*., 2019). Observations of sedation scores during endotracheal intubation and extubation showed no significant differences based on the t-tests (Table 1). The lack of significant differences in intubation sedation scores suggests homogeneity in the sample cats. Additionally, the non-significant results in the extubation sedation scores indicated similar sedation quality between the two treatment groups.

The recovery time showed considerable variability among the experimental groups, without any significant differences (Figure 3). The average recovery time for TZ group was 42.6 ± 25.07 min, which was longer than EA (29.3 ± 30.66 min). This phenomenon could be attributed to fluctuations in isoflurane requirement levels, which showed a downward trend. The ability of EA to accelerate recovery time has also been

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reported in other studies. Hammond (2023) concluded that the use of intraoperative EA could reduce the time from discontinuation of isoflurane to extubation in healthy dogs undergoing elective surgery. In a study by Ingerson (2023), the combination of atipamezole and EA after anesthetic procedures did not significantly accelerate anesthetic recovery time, but the use of EA alone significantly prolonged the duration of post-anesthetic recovery time.

Heart rate (HR) in adult cats is reportedly 128 ± 17 bpm according to Beglinger *et al.* (2010), while Ware (1999) reported that the heart rate of adult cats typically ranges from 114 to 202 bpm. During isoflurane maintenance, heart rate was 154 ± 12.99 bpm in TZ and 171.6 ± 12.02 bpm in EA group. These values fall in the normal range according to Ware (1999) and are slightly above in line with Beglinger (2010). The results showed no significant difference in heart rate between the two experimental groups at any of the observed time points. Additionally, AUC calculations, based on the t-test, for TZ group were 4647 ± 647.4 and for EA group 5094 ± 495.8, showing no significant difference. These results confirmed that the quality of anesthesia provided to both groups was similar.

Blood pressure was categorized into three observational variables, namely SAP, DAP, and MAP. The t-test results showed no significant differences for any of blood pressure measurements across all observation time points (Table 2), suggesting that EA could regulate blood pressure. These results were similar to those of Lin *et al*. (2010), who demonstrated that the increase in blood pressure induced by ketamine-xylazine could be counteracted by adding EA to anesthetic procedure. This study used TZ as isoflurane induction agent, a combination known to be safe for cardiac function. Therefore, neither TZ, nor EA group showed significant differences in any of the blood pressure measurements, although this study lasted for 30 min. A longer study will be needed to evaluate EA properties in the extended anesthesia time. EA in cats is likely attributable to the inhibition of arterial chemoreceptor pressure reflexes as opposed to the activation of baroreceptor reflexes (Lin *et al.*, 2010). Nevertheless, EA affects hemodynamic stability. The antihypertensive and antihypotensive effects of EA are contingent on the specific choices made in EA protocol.

Electrocardiogram (ECG) recordings were taken immediately before intubation and extubation to evaluate the effect of acupuncture modulation on cardiac electrical function. T-test results (Table 3) showed no significant differences between the groups, suggesting that EA did not significantly affect cardiac function. Both groups experienced tachycardia and sinus arrhythmia. Tachycardia was observed in all cats shortly before intubation and extubation. In EA group, tachycardia was observed at intubation time. However, three of cats experienced sinus arrhythmia, and the others had tachycardia at extubation time. Tachycardia is a known side effect of TZ (Dela Pena and Cheong, 2016).

The intraocular pressure (IOP) recorded for both groups was 21.9 mmHg. This value falls in the normal range established by Kovalcuka *et al.* (2024), who observed that the normal IOP range in cats was 18.88 ± 3.98 mmHg (TonoVet®) and 18.78 ± 4.26 mmHg (TonoVet Plus®). Various anesthetic agents can alter IOP by increasing extraocular muscle tone or the rate at which aqueous humor is produced and drained (Gelat 2011; Jang *et al.*, 2015). Jang *et al.* (2015) described the result of TZ, which demonstrated the unaltered value of IOP in dogs. This study confirmed that both TZ and EA had no effects on IOP value.

The normal resting respiratory rate for cats ranges from 16–60 breaths per min, and 9–28 breaths per min during sleep (Dijkstra *et al*., 2018). Respiratory rates in TZ (23.35 ± 3.58) and EA (15.8 ± 0.93) groups were in normal limits. Statistical analysis showed no significant differences between the groups at any of the specified time points. Additionally, AUC values for TZ (674 ± 136.7) and EA (468 ± 64.89) groups also showed no significant difference. These results suggest that acupuncture modulation did not significantly affect the respiratory rate during anesthesia.

The oxygen saturation status (SpO_2) of domestic cats under isoflurane anesthesia, according to Barter *et al*. (2004), falls in the range of 99.2 ± 1.1 or greater than 95%. Similarly, Mann *et al*. (1997) stated that healthy domestic cats should maintain an oxygen saturation level above 90%. In this study, the oxygen saturation levels in both treatment groups during isoflurane administration were in the range of 96.9 ± 0.5 (TZ) and 98.5 ± 0.58 (EA). Both groups maintained SpO_2 values in the normal range according to the references of Barter *et al.* (2004) and Mann *et al*. (1997). The results demonstrated that there was no statistically significant difference in SpO_2 values between the two groups based on changes over time. AUC calculations conducted using the t-test for TZ (2908 ± 32.02) and EA (2938 ± 21.20) groups showed no significant differences. These results suggest that anesthetic method of acupuncture modulation did not significantly affect changes in oxygen saturation.

The potential mechanisms underlying anesthetic modulatory effects of acupuncture include several possible approaches. As stated by Lu *et al*. (2015), the recommended points for lower abdominal surgery are ST-36 and SP-6 in the context of perioperative acupuncture modulation, to surpass the effects of anesthesia. The use of these points in EA stimulation has been demonstrated to attenuate the stimulation of peripheral nociceptors through the activation of Treg cells and the reduction of inflammatory mediator expression (Dou *et al*., 2021). Cassu *et al*. (2012) found that EA can stimulate the production of endogenous morphines such as dynorphins, endorphins, and enkephalins, with the type of morphine produced depending on stimulation. Based on study by Dou *et al.* (2021), low-frequency EA promotes the liberation of enkephalins through interaction with μ and δ receptors. High-frequency EA facilitates the release of dynorphins through engagement with μ receptors. Various mechanisms of acupuncture are assumed to increase anesthetic effect, thereby maintaining the quality of anesthesia even when the dose is reduced.

The release of opioids from CNS, accompanied by cardiovascular physiological changes, may affect the quality of anesthesia resulting from the use of anesthetic regimen combined with acupuncture (Fikri *et al*., 2025). A study conducted by Cassu *et al*. (2012) using ST-36 and SP-6 also described the classic theory of "Gate Control Theory", stating that the stimulus promoted by needles introduced intradermically can activate large nerve fibers (Aβ fibers) and change pain perception in the spinal cord. According to Lin *et al*. (2010), EA activates the nucleus arcuatus (ARC) in the hypothalamus, which sends stimulation from the periaqueductal gray (PAG) to the nucleus raphe obscurus (NRO). The activation of Nucleus Raphe Obscurus (NRO) neurons exerts inhibitory effects on cardiovascular neurons in the rostral ventrolateral medulla (rVLM), which subsequently engages opioid, GABA, and 5-HT receptors. Reflex changes in the chemoreceptors in the arteries are physiologically affected by the use of EA.

High doses of isoflurane may be associated with the risk of hypercapnia (Hodgson *et al*., 1998), decreased blood pressure, and stroke index (Machado *et al*., 2022). The risk of side effects may be avoided by reducing isoflurane requirement. In this study, isoflurane requirement in EA group was found to be lower than that of TZ. This result reinforces the ability of EA to reduce isoflurane requirement during anesthesia procedures. Additionally, all observed parameters related to anesthetic quality, cardiovascular function, and respiratory function showed no statistically significant differences between the two groups. This suggests that the sedation quality and safety levels achieved by both groups were relatively comparable.

CONCLUSION

This study showed that anesthetic method of combining EA and TZ significantly reduced isoflurane requirement in domestic cats during anesthesia procedures. The results indicate that the combination of acupuncture and anesthetic agents offers sedation quality and safety levels comparable to those achieved without acupuncture.

ACKNOWLEDGEMENTS

This study was supported by the Directorate of Research and Innovation, IPB University – Fundamental Research Grant (Penelitian Ri-Fund) 2023 with grant number 446/IT3.D10/PT.01.03/P/B/2023 to investigate the effects of acupuncture as anesthetic in small animals. The authors are grateful to IPB University, including the Graduate School, School of Veterinary Medicine and Biomedical Sciences, and Animal Hospital.

AUTHORS' CONTRIBUTIONS

The authors contributed to the study in various capacities, including methodology, validation, formal analysis, and investigation. SW was responsible for the validation, resources, data curation, and original draft, including writing and editing. RS and RHS reviewed the original draft, supervised and managed the project, and secured funding.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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