NOTE *Surgery*

Effects of Electroacupuncture on Intraocular Pressure and Hemodynamic Parameters in Isoflurane Anesthetized Dogs

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ABSTRACT. The effects of electroacupuncture (EA) on intraocular pressure (IOP) and hemodynamic parameters were evaluated in isoflurane anesthetized 10 (5 males, 5 females) normal mongrel dogs (8.1–9.8 kg, 6–8 years old). After determination of baseline IOP and hemodynamic parameters (cardiac index, systolic arterial pressure, diastolic arterial pressure, heart rate and systemic vascular resistance index), EA was applied at 3 acupoints (LI-4, LIV-3 and GB-37) for 20 min. After the EA treatment, IOP was significantly decreased in the both eyes ($p<0.05$). However, there were not significant differences in hemodynamic parameters between those of before and after EA treatment. From these results, the EA treatment at LI-4, LIV-3 and GB-37 would be considered one of the valuable methods for the IOP treatment in dogs.

KEY WORDS: electroacupuncture, hemodynamic parameters, intraocular pressure.

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Acupuncture has been clinically used to treat patients suffering from myopia, glaucoma, and retinitis pigmentosa (degeneratio retinae pigmentosa) in the field of ophthalmology [2]. From the previous study, 3 acupoints (LI-4, LIV-3 and GB-37) have been known for the therapeutic effect for decreasing the intraocular pressure (IOP) in humans and animals [5, 10]. Electroacupuncture (EA) has been used as more common type of acupuncture treatment than manual acupuncture [11]. In addition, electrical stimulation has been known to have an advantage of being less painful than manual stimulation [3]. Chu *et al.* also reported the ocular hypotension induced by EA treatment in rabbits [1]. Acupuncture or EA stimulation causes to induce various cardiovascular effects depending upon the chosen acupuncture point [7]. In case of EA stimulation at LI-4, LIV-3 and GB-37, the cardiovascular effects have not been reported. This study was performed to evaluate the effects of simultaneous EA stimulation at LI-4, LIV-3 and GB-37 acupoints on IOP and hemodynamic parameters in isoflurane anesthetized dogs.

This study adhered to the strict guidelines of the "Guide for the Care and Use of Laboratory Animals" of Seoul National University. Ten healthy mongrel dogs (8.1–9.8 kg, 6–8 years old, 5 males and 5 females) were used in this study. Dogs were divided into an EA group (n=5) and a control group (n=5) regardless of their body weight, age, and sex. Food was withheld for 12 hr before the experiment.

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Anesthesia was induced with intravenous bolus administration of ketamine HCl (KEIRAN® inj, Korea Unites Pharm, Korea) at a dose of 10 mg/kg. After induction, an endotracheal tube was placed and the anesthesia was maintained by using 1.2MAC isoflurane (Rhodia Isoflurane®, Hana Pharm., Korea) under pure oxygen. To measure hemodynamic parameters, catheterization procedures were performed under general anesthesia [8]. A 20 gauge over the needle catheter (D&B-Cath®, Sin Dong Bang Medical Co., Seoul, Korea) was inserted into femoral artery and 5F, 90 cm long flow-directed thermodilution catheter (BIOTRAY TD1504HD (LUER)®, Biosensors International Ltd., Singapore) was placed in the pulmonary artery via left jugular vein. These catheters were connected to anesthetic patient monitoring system (S/5 Anesthesia Monitor®, Datex-Ohmeda, Helsinki, Finland).

Baseline IOPs and hemodynamic parameters were measured at one hour after induction of anesthesia in order to stabilize the animals. For the EA group, sterile disposable stainless steel needles (0.2 × 30 mm, Dong Bang Acupuncture Inc., Seoul, Korea) were inserted bilaterally into LI-4, LIV-3 and GB-37 acupoints at 10 min after taking baseline parameters and kept for 20 min under the anesthetic condition (Fig. 1). All of the acupuncture needles were connected to electrical stimulator (Pulse Stimulator AM 3000, Tokyo Electrical Co., Tokyo, Japan) and electrical stimulation was applied at 2–4 V and 25 Hz. During this EA period, no other treatment was done for the control group. IOP (mmHg) was measured at 10 min before, 10 min, 20 min and 40 min after EA treatment, using tono-pen tonometer (MENTOR® TONO-PEN™XL, Mentor O & O, Inc., U.S.A.). The probe tip was contacted repeatedly to the central cornea. Average IOP was displayed along with the range of coefficient of

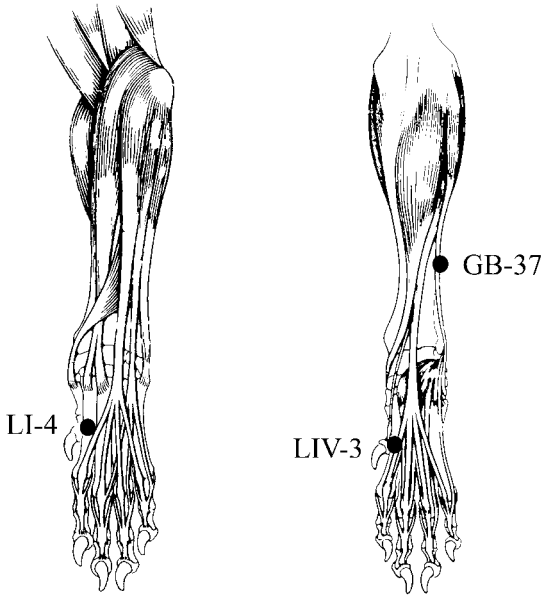

Fig. 1. The location of acupoints for the electroacupuncture treatment. LI-4: between the first and second metacarpal bones, at the level of the head of the first metacarpus; LIV-3: on the medial aspect of the hind paw, in the middle of the second metatarsal bone; GB-37: at the level of one-third of the distance from the tip of the external malleolus to the anterior border of fibular head.

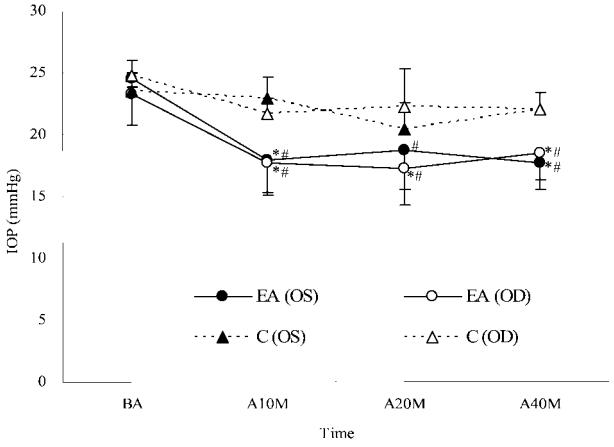

Fig. 2. The changes in intraocular pressure before and after electroacupuncture treatment in isoflurane anesthetized dogs. EA: electroacupuncture group; C: control group; OD: right eye; OS: left eye; BA: 10 min before treatment; A10M: 10 min after electroacupuncture (EA); A20M: 20 min after EA; A40M: 40 min after EA. *Significantly different from the control group ($p<0.05$), # Significantly different from the BA ($p<0.05$).

variance (5, 10, 20, or > 20%). The IOP was accepted as valid only with a reading of ≤5% variance for the both eyes [5]. To evaluate the cardiovascular system, cardiac index (CI), systolic arterial pressure (SAP), diastolic arterial pressure (DAP), mean arterial pressure (MAP), central venous pressure (CVP) and heart rate (HR) were measured directly by using anesthesia patient monitoring system. From the above data, systemic vascular resistance index (SVRI) was calculated as follows: SVRI = (MAP – CVP)/Cardiac output•Body surface area × 79.9 (dyn•sm^2/cm^5) [8].

Data were presented as mean ± standard deviation (SD). Paired *t* test was used to compare the baseline IOP and hemodynamic parameters in each group. The IOP and hemodynamic parameters between 2 groups were evaluated by the Kruskal-Wallis test. The levels of significance were chosen as $p< 0.05$.

The baseline IOPs of control group and EA group were not significant. In the control group, the baseline IOPs were measured at 23.50 ± 1.50 mmHg for left eye and 24.57 ± 1.29 mmHg for right and they did not show any significant change during the course of experiment. In the EA group, the baseline IOPs were measured at 24.50 ± 0.58 mmHg and 23.25 ± 2.50 mmHg for left and right eyes, respectively. However, the IOPs in EA group were significantly decreased after EA treatment ($p<0.05$). Ten minutes after EA treatment, the IOPs were measured at 18.00 ± 2.71 mmHg for left eye and 17.75 ± 2.60 mmHg for right eye. Subsequently, IOPs of the EA group were kept significantly lower than those of the control group (Fig. 2). In the measurement of the hemodynamic parameters, no significant differences were found between those of before and after EA treatment. In addition, there were not significant differences in hemodynamic parameters between the control groups and the EA group during the course of experiment (Table 1).

Recently, nonpharmacological treatment, such as acupuncture, has been researched as to treating any ocular diseases [2, 10]. The IOP is generated by the dynamic process of the aqueous [4]. Lowering of IOP by acupuncture or EA stimulation has been known to association with suppression of the rate of aqueous humor by reducing the norepinephrine level, a reduction of blood pressure, and increase of the endorphin levels [1, 11, 12]. Acupuncture or EA stimulation has been studied to produce the autonomic effect, which is either sympathomimetic or parasympathomimetic [7]. The changes of these effects may be determined by choosing acupoint. Acupuncture stimulation at GV26 resulted in increased cardiac output, HR and MAP, while at ST-36 it induced a significant decrease in cardiac output, HR and mean arterial pressure [6, 7]. In this study, EA treatment at LI-4, LIV-3 and GB-37 had beneficial effect on decreasing IOP without adversely affecting the cardiovascular system or inducing obvious adverse effects. This study might be the first to evaluate the effects of EA on IOP and hemodynamic parameters under isoflurane anesthesia in dogs. Systemic cardiopulmonary effects and some hormones, which are changed by acupuncture or EA stimulation, appear to have not yet elucidated [9]. Further studies should be required to investigate the therapeutic effect on IOP by acupuncture stimulation.

Table 1. The changes in hemodynamic parameters after electroacupuncture treatment in isoflurane anesthetized dogs

Hemodynamic parameters	Group	Time			
		BA	A10M	A20M	A30M
CI (L/m^2/min)	Control	5.01 ± 0.79	5.42 ± 0.43	4.92 ± 0.76	4.98 ± 1.53
	EA	5.73 ± 1.41	6.64 ± 0.96	5.81 ± 1.40	5.46 ± 1.40
SAP (mmHg)	Control	146.25 ± 22.41	144.75 ± 16.32	144.75 ± 11.59	154.50 ± 16.05
	EA	141.25 ± 22.50	138.75 ± 22.05	134.00 ± 21.68	140.25 ± 22.38
DAP (mmHg)	Control	88.50 ± 21.67	85.50 ± 14.80	85.25 ± 12.07	92.00 ± 15.77
	EA	82.50 ± 21.14	78.50 ± 20.27	74.00 ± 16.91	75.75 ± 17.69
HR (beat/min)	Control	150.50 ± 27.54	153.25 ± 32.77	161.75 ± 35.23	157.50 ± 28.87
	EA	132.50 ± 28.24	137.00 ± 24.70	129.75 ± 19.17	127.25 ± 22.11
SVRI (dyn•s•m^2/cm^5)	Control	430.83 ± 146.42	460.43 ± 91.73	413.88 ± 87.41	454.74 ± 175.56
	EA	461.06 ± 135.57	457.47 ± 57.09	448.60 ± 105.51	447.02 ± 89.29

Data are expressed as mean ± SD. CI: Cardiac index; SAP: systolic arterial pressure; DAP: diastolic arterial pressure; HR: heart rate; SVRI: systemic vascular resistance index; BA: 10 min before treatment; A10M: 10 min after electroacupuncture (EA); A20M: 20 min after EA; A40M: 40 min after EA.

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