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Effect of Electroacupuncture Analgesia on Changes of Vital Signs and Blood Chemical Values in Cats

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Abstract : The present study was performed to investigate the anesthetic or analgesic effect of tiletamine-zolazepam (TZ) and electroacupuncture analgesia (EAA) in cats. Twelve healthy cats were randomly assigned to receive either TZ or EA. TZ group cats with weight of 3.65 ± 0.48 kg received 10.0 mg/kg of TZ intramuscularly. EA group cats with weight of 3.62 ± 0.52 kg received 5 V, 30 Hz and 60 minutes of EA. The acupoints used were Tian-ping (GV-5, +), Bai-hui (GV-20, –). Therefore, after and before experiment, some serum chemistry profiles (alkaline phospatase, aspartate aminotransferase, alanine aminotransferase, glucose and total protein) and change of vital signs (rectal temperature, heart rate, respiratory rate) were examined. All cats were examined pre, and 5, 25, 65 and 105 minutes after administration of TZ or operation of EA. The cats in EA group showed a smaller change in rectal temperature, heart rate and respiratory rate than in the TZ group ($p < 0.05$). In both groups, total protein concentration was constant throughout the period of anesthesia, and the serum glucose increased gradually throughout the period of anesthesia. However, the cats in EA group showed a smaller change in alkaline phospatase, aspartate aminotransferase and alanine aminotransferase within the limit of safety than in the TZ group ($p < 0.05$). While coming to induction, the TZ group took a mean 2.4 ± 0.7 minutes to achieve sternal recumbency, compared with 10.5 ± 2.1 minutes by the EA group, and 3.2 ± 0.6 minutes to achieve lateral recumbency, compared with 18.8 ± 1.9 minutes by the EA group ($p < 0.05$). When recovering from anesthesia, the TZ group took 164.3 ± 17.9 minutes to achieve sternal position time, compared with 67.7 ± 4.6 minutes by the EA group, and 202.0 ± 15.7 minutes to stand, compared with 73.0 ± 6.1 minutes for the EA group ($p < 0.05$). In this study, the cats anesthetized with EA showed a more rapid recovery rather than the cats under TZ anesthesia. Also, there do not appear to be any negative physiologic effects associated with acupuncture-induced surgical analgesia. So, it was considered that EAA may be used effectively in shock, debilitated cats, as compared to TZ.

Key words **:** anesthesia, analgesia, electroacupuncture, cat, tiletamine-zolazepam.

Introduction

Anesthesia is an artificial state that is chemically induced and to some extent resembles sleep from which the patient is not arousable (11). During anesthesia, conscious, sensual, motional and self-reflex function was reduced or altered (11). In fact, anesthesia occurs in condition altered or lost of these functions simultaneously. But general anesthesia by drug or inhalation is difficult in the patient with weakness or liver failure.

Therefore, acupuncture analgesia is one of the efforts to resolve that problem through the oriental medicine, recently. The acupuncture can be used to induce pain relief (hypalgesia) in clinical disorder and as a complementary method of pain control during surgical procedures in well-restrained, large and small animal patient. Acupuncture analgesia has been reported for cattle (6,13), goat (9), cat (5,16) and dog (4,15,16). In China, veterinary acupuncture analgesia is applied not only to surgery of domesticated animals, but to surgery some zoo animals ranging from the deer to the lion (2). There do not appear to be any negative physiologic effects associated with acupuncture-induced surgical analgesia, such as respiratory depression or decreased blood pressure and cardiac output, as produced by the various injectable or inhalant anesthetics (7). Acupuncture analgesia is best achieved by electrostimulation through acupuncture needles in acupuncture points. Many acupuncture points can be used to induce electroacupuncture analgesia (EAA) in animals (12). The major advantages of electroacupuncture (EA) are good analgesia in high-risk patients without producing CNS and respiratory depression, bradycardia, and hypotension commonly observed after the use of

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sedatives, opioids, and general anesthetics; excellent postoperative pain relief; fast postoperative recovery of appetite and gut and bladder function; and fast postoperative wound healing with minimal infection (12). While drug anesthesia has a shorter induction period and deeper maintenance than EAA, it can be limited in such a case as infant or liver failure patients.

Tiletamine [2-(ethylamino)-2-(2-thienyl) cyclohexanone hydrochloride] was first reported in 1969. It is a dissociative anesthetic agent with pharmacologic properties similar to those of ketamine, but it has longer duration of action and greater analgesic effect than that of ketamine (10). And zolazepam [4-(o-fluorophenyl)-6,8-dihydro-1,3,8-trimethyl-pyrzole [3,4-e] diazepine- 7(1H)-one] is a benzodiazepine derivative with pharmacologic properties similar to those of diazepam. Zolazepam is a group of a benzodiazepine with pharmacological actions similar to anti-anxiety agent. It is used for immobilization and anesthesia in animals. Tiletamine quickly induces satisfactory levels of anesthesia, but it has short duration of anesthesia and poor muscle relaxation and does not effect upon visceral pain. On the other hand, zolazepam was chosen to combine with tiletamine because of its effectiveness as an anti-convulsant and muscle relaxant (10). Zoletil® (Virbac, France) is a 1 : 1 mixture by weight of tiletamine and zolazepam. It has been proved to be a very useful drug for an induction of anesthesia in a wide variety of wild and domestic animals (8,10). The adverse effects include respiratory depression, vocalization erratic and/or prolonges recovery, involuntary muscular twitching, hypertonia, cyanosis, cardiac arrest, pulmonary edema and either hypertension or hypotension. Pain after IM injection (especially in cat) has been noted which may be a result of the low pH of the solution (10).

Cats object to being restrained and even friendly cats may prove difficult to inject intravenously, and unhandled cats may be impossible to anesthetize using this route. For this reason it may be necessary to give parenteral drugs by other routes. Additionally, cats are small in size and this means that the margin of error is small. Thus, using large syringes and needles can compromise accurate dosage so that anesthetic overdoses are easy. Moreover, cats are more sensitive unlike the other pets and still has wildness themselves, so that it's difficult to put them under anesthesia, so, sometimes need assistants to do that. General anesthesia by drug or inhalation is difficult in the patient with weakness or liver failure. In cats, the only toxic effects of tiletamine-zolazepam (TZ) observed at 2.0 to 12.5 times higher than the intended clinical dosage were a dose-related lesion at the injection site and elevations of aspartate aminotransferase (AST) (11). Therefore, after and before experiment, we examined alkaline phospatase (ALP), AST, alanine aminotransferase (ALT), glucose and total protein (TP) as liver profile blood chemical values.

The purpose of this study is to determine the effect of EA as a substitute for injectable anesthetic drugs in cats. Therefore, EA group as a treatment group and TZ group as a control group were divided for this study. Thus, changes of induction and recovery values, vital signs and blood biochemical values were determined in cats applied with EA treatment.

Materials and Methods

1. Experimental Design

In this study, 1-year-old, twelve healthy mixed breed cats were used. These cats were consisted of 8 females and 4 males. The cats were examined the body condition (CBC, serum chemistry profile, heart worm, other parasite, fecal test and vital sign) 1 month before the experiment. They were fed a dry food (Science diet®, Hill's Co., USA) and a moist food (Cesar®, Uncle ben's, Co., Australia). Food and water were withheld for 12 hours prior to the experiments. These cats were assigned at randomly to the following control group (TZ group) and treatment group (EA group). EA group cats with weight of 3.62 ± 0.52 kg received 5 V, 30 Hz and 60 minutes of EA. TZ group cats with weight of 3.65 ± 0.48 kg received 10.0 mg/kg of Zoletil® (Zoletil 50, Virbac, France). All drugs were injected intramusculary. All cats were examined at pre-treatment (pre), and 5, 25, 65 and 105 minutes after TZ injection or EA.

The acupuncture needles were inserted into Tian-ping (Celestial Peace, GV-5,), Bai-hui (Hundred Meetings, GV-20), with the former connected to a positive electrode and the latter connected to a negative electrode, respectively. The animals were stimulated with electric conditions of 1~5 V and 30 Hz using veterinary electroacupuncture apparatus (TEC-AM 3000, Tokyo Electric Co., Japan).

The present study was performed according to the rules of the ethics Committee for Experimental Animals, Chungnam National University.

2. Induction and recovery

The cat's induction was recorded as the times from injection to when they achieved sternal recumbency, and to when they achieved lateral recumbency. The recovery was recorded as the times from injection to when they achieved sternal position, and to when they stood up.

3. Vital signs

Physiological parameters were monitored. Rectal temperature was measured with a digital thermometer, and heart rates were measured by stethoscope. Respiratory rates were measured by observing the abdominal movement. Rectal temperature, heart rates and respiratory rates were determined pre, and 5, 25, 65 and 105 minutes after TZ or EA administration.

4. Blood biochemistry

Blood samples were collected at each time point by venepuncture from a cephalic vein into a plain tube and left to coagulate. They were then centrifuged at 650 g for 15 minutes and the serum was separated. Serum sample data containing ALP, AST, ALT, glucose and total protein (TP) were

Table 1. Induction and recovery variation in cats anesthetized with tiletamine-zolazepam (TZ) and electroacupuncture (EA)

Group	Sternal recumbency time (induction)	Lateral recumbency time (induction)	Sternal position time (recovery)	Standing position time (recovery)
TZ	2.4 ± 0.7 [a]	3.2 ± 0.6[a]	164.3 ± 17.9[a]	202.0 ± 15.7[a]
EA	10.5 ± 2.1[b]	18.8 ± 1.9[b]	67.7 ± 4.6[b]	73.0 ± 6.1[b]

Values at the same column with different letters are significantly different ($P < 0.05$).

obtained using TOSHIBA 30FR Blood Chemistry Analyzer. Blood biochemistry was determined pre, and 5, 25, 65 and 105 minutes after EA or TZ administration.

5. Statistical Analysis

All statistical calculation was performed with the Microsoft Excel (Microsoft, USA) and SPSS 10.0 (SPSS Inc. USA). All data were expressed as mean ± standard deviation. Induction and recovery, vital signs (rectal temperature, heart rates and respiratory rates), serum biochemistry (ALP, AST, ALT, glucose and TP) were analyzed by two-way ANOVA analysis of variance for repeated measures to compare time-related variables within each anesthetic group. The significance level of all the tests was set at $P < 0.05$.

Results

1. Induction and recovery

The cats in control group rapidly became sedated after the intramuscular injection of TZ. On the other hand, the cats in treatment group slowly came to analgesia after EA.

While coming to induction, the TZ group took a mean 2.4 ± 0.7 minutes to achieve sternal recumbency, compared with 10.5°æ2.1 minutes by the EA group, and 3.2 ± 0.6 minutes to achieve lateral recumbency, compared with 18.8 ± 1.9 minutes by the EA group ($p < 0.05$).

When recovering from anesthesia, the TZ group took 164.3 ± 17.9 minutes to achieve sternal position time, compared with 67.7 ± 4.6 minutes by the EA group, and 202.0 ± 15.7 minutes to stand, compared with 73.0 ± 6.1 minutes for the EA group ($p < 0.05$) (Table 1).

As a result, EA group revealed very faster recovery than TZ group.

2. Rectal temperature

The mean rectal temperature of the two groups gradually increased for 5 minutes after drug injection or EA. Thereafter, the rectal temperature in the TZ group gradually decreased, but the rectal temperature in the EA group slightly increased up to 25 minutes and then gradually decreased.

Rectal temperature showed significant difference between the two groups (Fig 1).

3. Heart rate

The heart rate in the TZ groups decreased rapidly up to 5 minutes after the administration of TZ, and then revealed constant value at 25 and 65 minutes and then slightly increased.

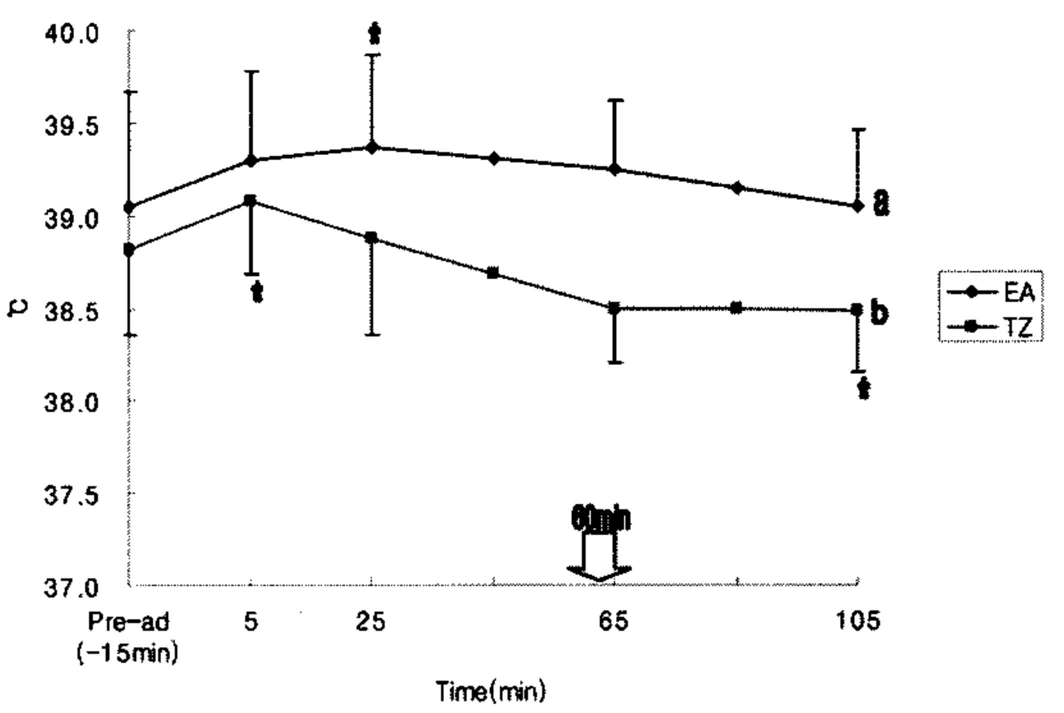

Fig 1. Rectal temperature in cats anesthetized with tiletamine-zolazepam (TZ) and electroacupuncture (EA). EA group cats received EA from zero to 60 minutes (arrow). Rectal temperature was significant difference between TZ and EA group. *Significantly different from baseline ($P < 0.05$). [a,b]Values marked with different letters represent significant difference between two groups with time-related variables ($P < 0.05$).

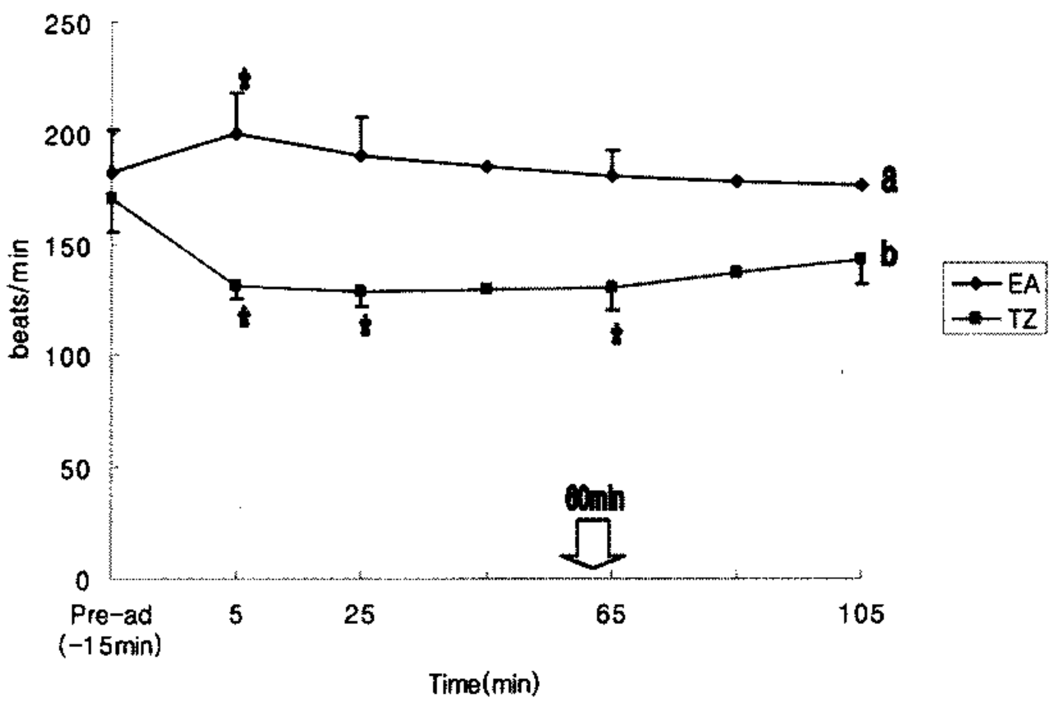

Fig 2. Heart rate in cats anesthetized with tiletamine-zolazepam (TZ) and electroacupuncture (EA). EA group cats received EA from zero to 60 minutes (arrow). *Significantly different from baseline ($P < 0.05$). [a,b]Values marked with different letters represent significant difference between two groups with time-related variables ($P < 0.05$).

In the EA group, the heart rate increased rapidly up to five minutes, and then tended to decrease slightly. There was significant difference between the heart rates of the two groups (Fig 2). Heart rate was significantly different between TZ and EA group.

4. Respiratory rate

The respiratory rate in the TZ groups decreased rapidly up to 5 minutes after the administration of TZ, and then revealed constant value at 25 and 65 minutes and then slightly increased.

In the EA group, the respiratory rate increased slightly up to five minutes, and then revealed constant value at 25 and 65 minutes and then slightly decreased.

There was significant difference between the heart rates of the two groups (Fig 3).

5. Blood chemistry

The concentration of TP in the TZ group was significantly higher than in the EA group throughout the period of anesthesia ($p < 0.05$) (Fig 4).

In both groups the concentration of ALP after 65 and 105 minutes was significantly higher than the pretreatment ALP ($p < 0.05$). The concentration of ALP in the TZ group was significantly higher than in the EA group throughout the period of anesthesia ($p < 0.05$) (Fig 5).

In the TZ group the concentration of AST from five to 105 minutes was significantly higher than the pretreatment AST ($p < 0.05$). In the EA group the AST concentration after 65 minutes was significantly higher than the pretreatment AST ($p < 0.05$). The concentration of AST in the TZ group was significantly higher than in the EA group throughout the period of anesthesia ($p < 0.05$) (Fig 6).

In the TZ group the concentration of ALT from 25 to 105 minutes was significantly higher than the pretreatment ALT ($p < 0.05$). In the EA group the ALT concentration after 65 minutes was significantly higher than the pretreatment ALT ($p < 0.05$). The concentration of AST in the TZ group was significantly higher than in the EA group throughout the period of anesthesia ($p < 0.05$) (Fig 7).

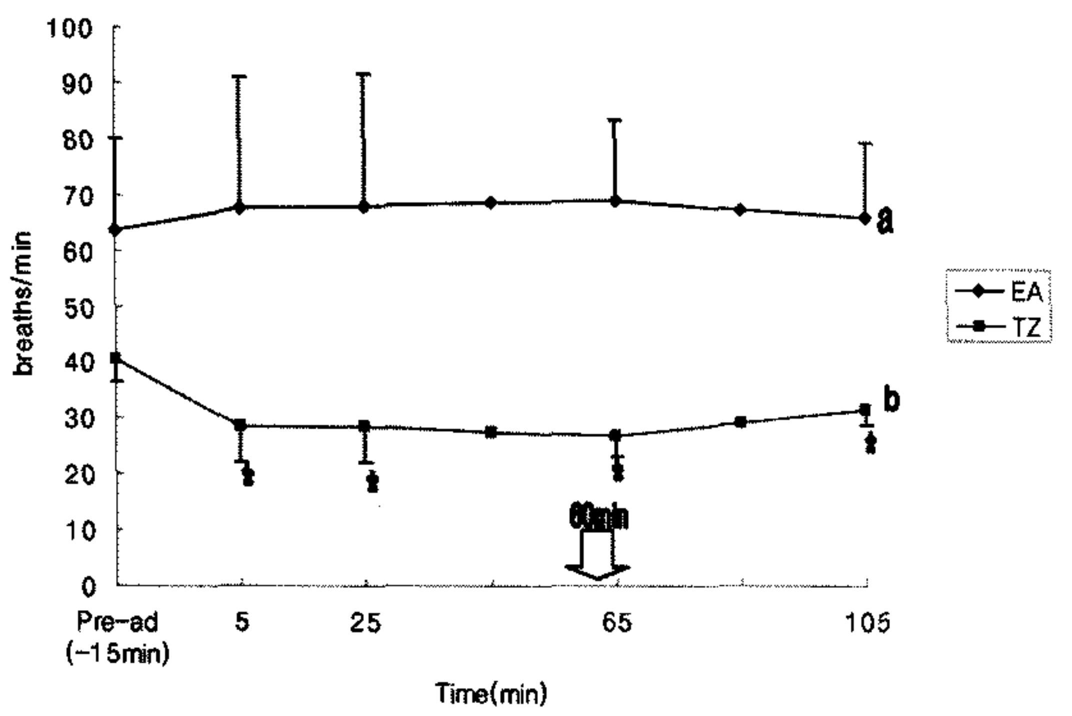

Fig 3. Respiratory rate in cats anesthetized with tiletamine-zolazepam (TZ) and electroacupuncture (EA). EA group cats received EA from zero to 60 minutes (arrow). Respiratory rate was significant difference between TZ and EA group. *Significantly different from baseline ($P < 0.05$). [a,b]Values marked with different letters represent significant difference between two groups with time-related variables ($P < 0.05$).

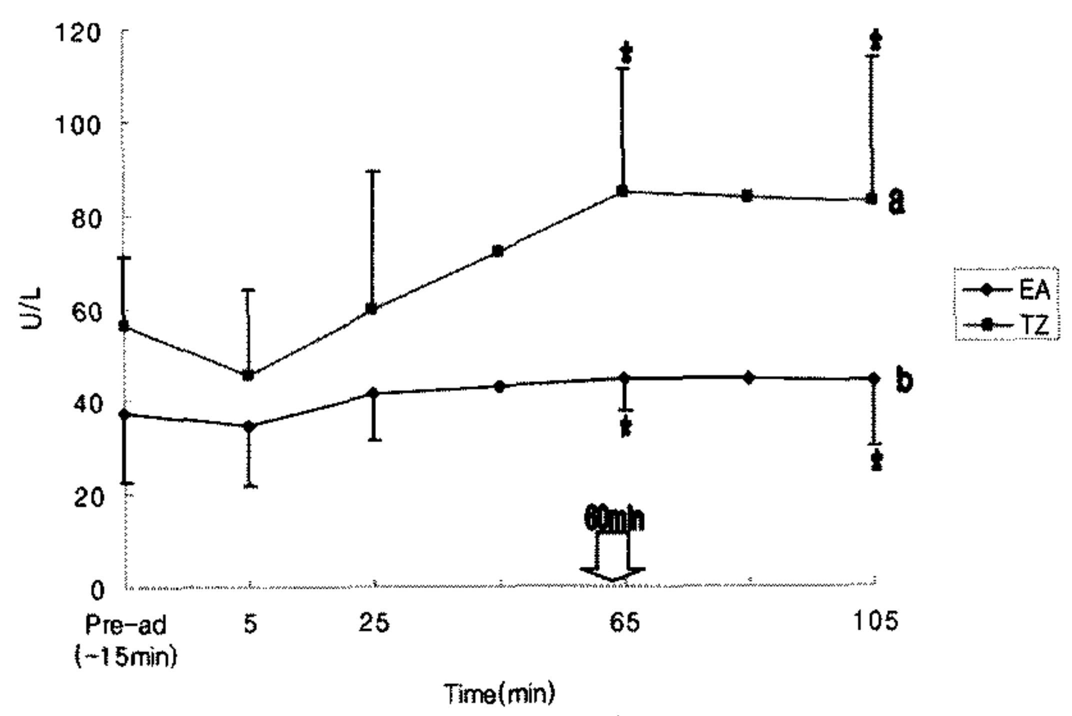

Fig 5. Serum ALP in cats anesthetized with tiletamine-zolazepam (TZ) and electroacupuncture (EA). EA group cats received EA from zero to 60 minutes (arrow). ALP was significant difference between TZ and EA group. *Significantly different from baseline ($P < 0.05$). [a,b]Values marked with different letters represent significant difference between two groups with time-related variables ($P < 0.05$).

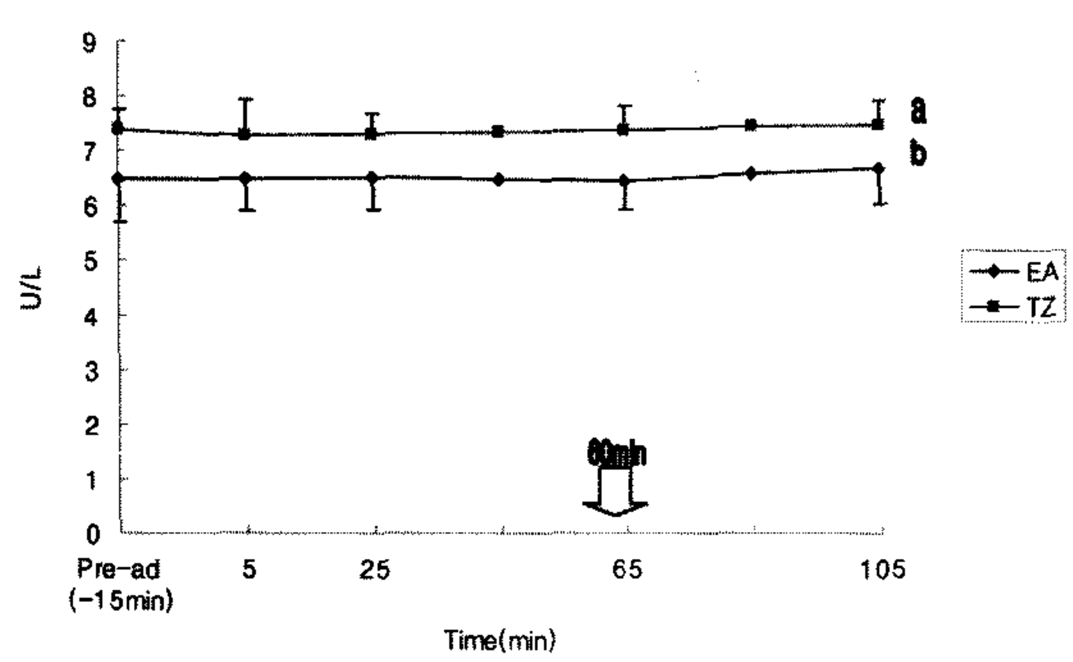

Fig 4. Serum TP in cats anesthetized with tiletamine-zolazepam (TZ) and electroacupuncture (EA). EA group cats received EA from zero to 60 minutes (arrow). TP was significant difference between TZ and EA group. *Significantly different from baseline ($P < 0.05$). [a,b]Values marked with different letters represent significant difference between two groups with time-related variables ($P < 0.05$).

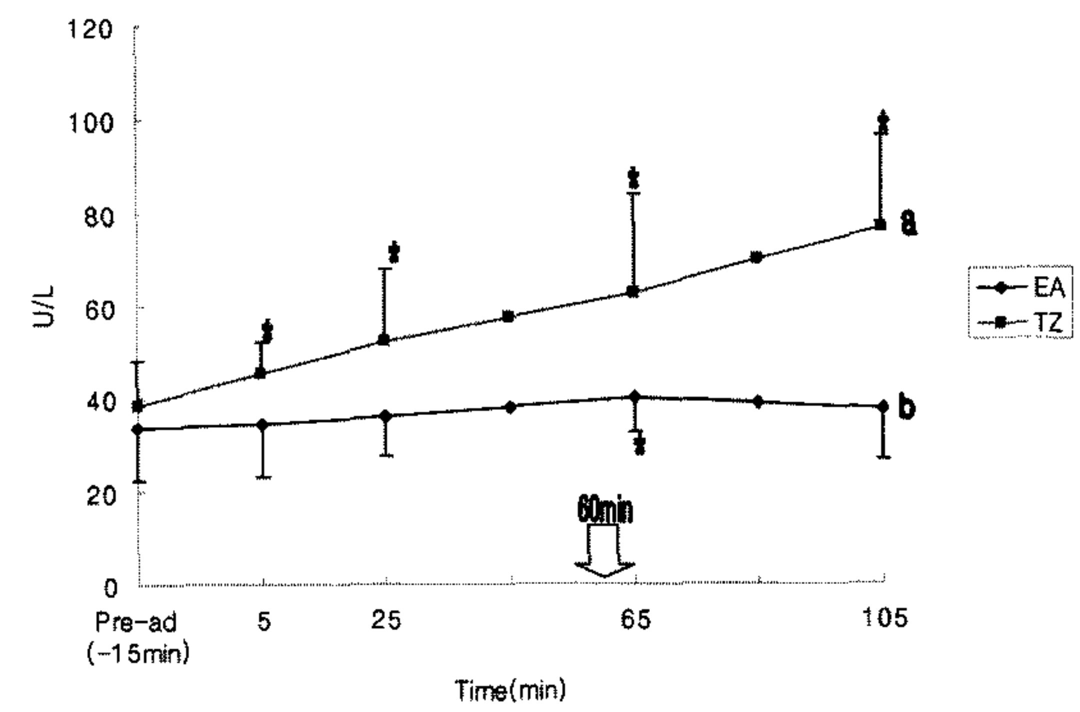

Fig 6. Serum AST in cats anesthetized with tiletamine-zolazepam (TZ) and electroacupuncture (EA). EA group cats received EA from zero to 60 minutes (arrow). AST was significant difference between TZ and EA group. *Significantly different from baseline ($P < 0.05$). [a,b]Values marked with different letters represent significant difference between two groups with time-related variables ($P < 0.05$).

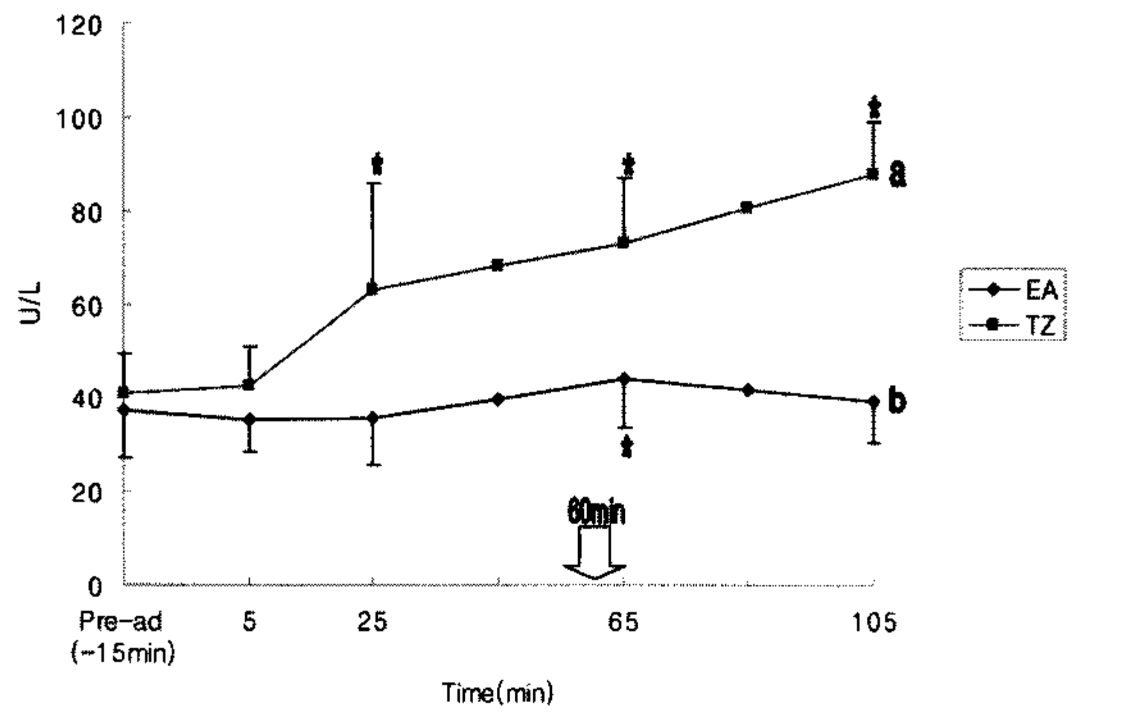

Fig 7. Serum ALT in cats anesthetized with tiletamine-zolazepam (TZ) and electroacupuncture (EA). EA group cats received EA from zero to 60 minutes (arrow). ALT was significant difference between TZ and EA group. *Significantly different from baseline ($P < 0.05$). [a,b]Values marked with different letters represent significant difference between two groups with time-related variables ($P < 0.05$).

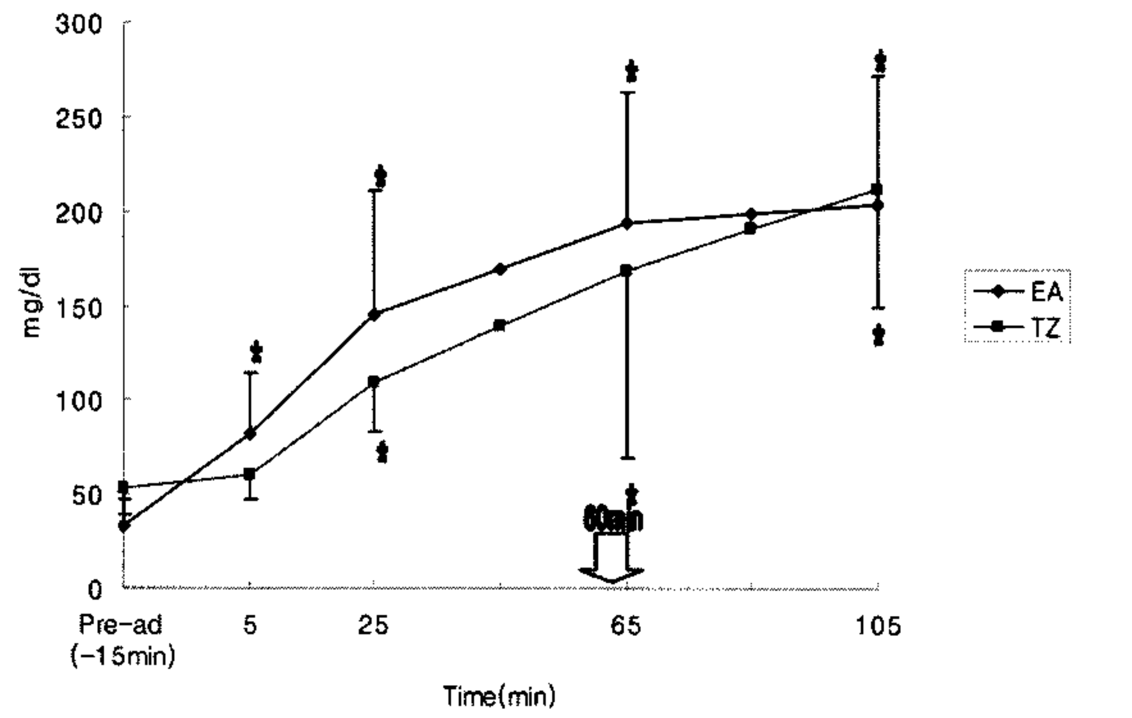

Fig 8. Serum glucose in cats anesthetized with tiletamine-zolazepam (TZ) and electroacupuncture (EA). Glucose was not significant difference between TZ and EA group. EA group cats received EA from zero to 60 minutes (arrow). *Significantly different from baseline ($P < 0.05$). [a,b]Values marked with different letters represent significant difference between two groups with time-related variables ($P < 0.05$).

In both groups, the serum glucose concentration increased gradually throughout the period of anesthesia. In the TZ group the glucose concentration from five to 105 minutes was significantly higher than the pretreatment glucose ($p < 0.05$). In the EA group the glucose concentration after 25 and 65 minutes was significantly higher than the pretreatment glucose ($p < 0.05$) (Fig 8).

Discussion

Pain modification is an important part of traditional acupuncture therapies. However, the idea of using acupuncture to alleviate pain has been greatly expended in the last three decades. One of the most unique features of EA is its suppression of pain without much disturbance of other physiological functions. The technique, therefore, is better termed EA than anesthesia (2). Acupuncture analgesia works by stimulation of large myelinated fibers which conduct the stimulus to the spinal cord and higher centers. The practical applications of acupuncture analgesia in small animal practice are limited and require co-operation of the owner and animal.

It is indicated especially in caesarians, high risk patients, such as gastric torsion and as a post-surgical analgesic (3).

Cats have difficulty in restraining and anesthetizing effectively unlike other animals. In this study, we examined the anesthetic or analgesic effect of control group with the use of TZ and treatment group with the use of EA in cats. In the present study, the induction time of anesthesia had little difference between both groups. The EAA does not need more time than the general anesthesia in recovery (12). In the present study, the recovery time of the cats anesthetized with EA also was much shorter than the patient in the TZ group.

In this study, the rectal temperature of the cats anesthetized with EA was less changeable than in case of TZ anesthesia. This result suggests that for the patient whose temperature is low under narcosis, the EA analgesia is safer than the TZ anesthesia. According to the report, EAA is suitable for animals that are in shock, debilitated, or toxic (12). In the present study, the cats in EA group showed a smaller change in heart rate and respiratory rate than in the TZ group. Therefore, the result of the present study supports above report for EAA (12).

In both groups, TP concentration was constant throughout the period of anesthesia, and the serum glucose increased gradually throughout the period of anesthesia. However, the cats in EA group showed a smaller change in ALP, AST and ALT within the limit of safety than in the TZ group. Therefore, the result of the present study also supports above report for EAA (12).

Experimental and clinical trials have found acupuncture-produced surgical analgesia to be effective in many species. One advantage is that it may preclude the need for depressant drugs, which could be useful when treating very sick or geriatric patients or when performing cesarean section (7). In this study, the cats anesthetized with EA showed a more rapid recovery rather than the cats under TZ anesthesia. Also, there do not appear to be any negative physiologic effects associated with acupuncture-induced surgical analgesia. So, it was considered that EAA may be used effectively in shock, debilitated cats, as compared to TZ.

Acknowledgements

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