Effect of electroacupuncture on post-caesarean section pain

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Abstract. Post-operative pain is a major clinical problem and must be managed properly. Various types of pharmacotherapy regimens have been used for managing post-operative pain. However, the results are still not satisfactory. This study aimed to determine the effects of electroacupuncture (EA) on post-caesarean section pain. This randomised control trial included 38 women who underwent caesarean section. The participants were divided into two groups: the EA group that received 2 Hz electroacupuncture at the ST36 Zusanli, SP6 Sanyinjiao, LI4 Hegu and LR3 Taichong points for 30 min and the control group that did not receive EA. Morphine was provided to both groups according to their individual needs through patient-controlled analgesia. The assessment was performed by measuring the total dose of morphine used within the first 24 h and during the time when a patient first requested for morphine after surgery. The results showed that the median amount of morphine consumption of the EA and control groups for 24 h were 4.5 and 15 mg, respectively (p < 0.05), and the median time to the first use of morphine in the EA and control groups were 205 and 60 min, respectively (p < 0.05). Thus, EA had an analgesic effect on post-caesarean section pain, as indicated by a delay in the time when a patient first requested for morphine and the decrease in the total dose of morphine that was used within the first 24 h after surgery.

1. Introduction

Pain is an unpleasant experience caused by tissue damage that is either happening or can potentially occur. Mild to severe post-operative pain is a major complaint or complication associated with surgery that occurs several hours to years and sometimes even a lifetime after surgery [1].

Caesarean section is the delivery of a foetus via surgical incisions in the abdomen (laparotomy), and it is currently the most common surgical procedure in the United States, with >1 million surgeries performed each year. In 2008, its incidence increased to 32% in the United States [2]. Data from the Department of Obstetrics Gynaecology, Cipto Mangunkusumo Hospital, Jakarta, has shown that caesarean delivery in 2012
has accounted for 1637 out of 3976 deliveries (41%). In 2011, there were 1129 caesarean deliveries out of 2951 deliveries (38.2%). Meanwhile, in 2010, 2009 and 2008, the delivery rate reached to 46%, 40% and 37%, respectively [3]. However, this procedure can also cause problems, such as post-operative pain, which is a major problem that results in chronic pain if left untreated [4].

Acupuncture has been widely used in China for over 4000 years. A recent research has shown a promising result regarding the use of acupuncture for managing post-operative pain due to various types of surgery [5]. Some studies have showed that acupuncture can reduce post-operative pain and the side effects of analgesics. Wu et al. (2009) investigated the effects of acupuncture and electroacupuncture (EA) on post-caesarean section pain in 60 women and showed that the average time to the first use of morphine in the acupuncture and EA groups was 40 and 39 min, respectively, whereas that in the control group was 29 min (p < 0.05). The total dose of patient-controlled analgesia (PCA) that was used by the acupuncture and EA groups within the first 24 hours after surgery was 30%–35% less than that used by the control group (p < 0.05). The visual analogue scale (VAS) scores of the acupuncture and EA groups within the first 2 h after surgery were significantly lower than those of the control group, and the number of opioid-related side effects, such as nausea, vomiting and dizziness, was significantly lower in the acupuncture and EA groups than in the control group (p < 0.05) [6].

At present, the use of analgesics for post-operative pain management still has an unsatisfactory effect. In addition, it can cause nausea, vomiting and gastrointestinal disorders. Therefore, the present study aimed to identify the effects of EA when combined with analgesic therapy and PCA on post-caesarean section pain by analysing the use of analgesics in terms of amount and demand for drug for the first time after surgery.

2. Methods
This randomised controlled trial included 38 women who underwent caesarean section and were treated in the gynecology–obstetric emergency room and central surgery installation of Cipto Mangunkusumo Hospital. The patients were classified into EA and control groups.

Patients who underwent caesarean section were included with inclusion criteria: those who did not previously undergo caesarean section, those who had no acupuncture experience, those with an American Society of Anesthesiologists (ASA) status of 1–2, those who underwent surgery and anaesthetic procedures that have been determined, those who did not present with intraoperative complications and did not use intraoperative analgesics, those who received 2 mg of morphine immediately after surgery, and those with a Bromage score of 0. Meanwhile, we excluded patients with contraindications to acupuncture and EA, those with post-operative complications, those who received additional analgesia medications other than those prescribed and those who underwent surgery for > 2 h. Patients who did not comply with the correct procedure and those who presented with cardiorespiratory emergencies were also excluded.

The following materials and equipment were used: Dong Bang® acupuncture needles (size: 0.25 mm × 40 mm and 0.25 mm × 25 mm), 70% alcohol swab, tensimeter, Hwato SDZ V® electrostimulator, CADD Legacy PCA ambulatory infusion pump, morphine and NaCl.

This research had been approved by the Health Research Ethics Committee of the Faculty of Medicine, Universitas Indonesia-Cipto Mangunkusumo Hospital (approval number: 407/H2.F1/ETIK/2013), and a research permission was obtained from Cipto Mangunkusumo Hospital (approval number: TUK/Lit/VII/2013). Informed consent was obtained from all participants.

Sampling was performed by randomly allocating the research participants using a random table. The medical research approval letter was signed before the participants underwent surgery. Post-caesarean section with a Bromage score of 0 then respondents in the EA group with supine position done with aseptic and antiseptic action at the points to be punctured. A puncture was made at Zusanli ST36, Sanyinjiao SP6,
Hegu LI4 and Taichong LR3 points until a needle sensation was felt by the patients, and the needle was then connected to the electrostimulator with a frequency of 2 Hz and a tolerable intensity for 30 min. Then, PCA installation was done. The assessment was performed by recording the time when a patient first requested for morphine after surgery and the total doses of morphine that were used within the first 24 h after PCA installation. In the control group, patients with a Bromage score of 0 received PCA while in the supine position.

Data were obtained using the patient’s form. The first request for morphine was obtained by observing the time after PCA installation until the patient first pressed the PCA button. The total doses of morphine were assessed within 24 h after PCA installation.

Statistical analysis was performed using unpaired t-test. When data with abnormal distribution were obtained, the Mann–Whitney U test with chi-square test was used for categorical data. A p-value of <0.05 was considered statistically significant.

3. Results

The present study included 38 female patients who underwent caesarean section and met the inclusion criteria (Table 1). Before starting therapy, the procedure was explained to the participants, including the needle sensation. No participant dropped out from the study.

Table 1. Characteristics of the study participants.

| Variables                  | Group          | p value |
|----------------------------|----------------|---------|
|                            | EA (n=19)      | Control (n=19) |   |
| Age (years)                | 29.05 (±4.76) | 30.52 (±6.14) | 0.414<sup>a</sup> |
| Systole (mmHg)             | 122 (97–140)  | 125.3 (110–140) | 0.647<sup>b</sup> |
| Diastole (mmHg)            | 60 (45–90)    | 78 (60–100)    | 0.218<sup>b</sup> |
| Pulse (beats/minutes)      | 80 (60–100)   | 84 (70–96)     | 0.155<sup>b</sup> |
| Types of surgery CITO      | 16/19         | 19/19         | 0.230<sup>c</sup> |
| Elective                   | 3/19          | 0/19          |   |
| ASA I                      | 3/19          | 2/19          | 1.00<sup>c</sup> |
| II                         | 16/19         | 17/19         |   |
| Education Elementary school| 1/19          | 0/19          | 0.324<sup>d</sup> |
| Junior high school         | 0/19          | 3/19          |   |
| Senior high school/D3      | 15/19         | 15/19         |   |
| S1                         | 3/19          | 1/19          |   |
| Occupation Housewife       | 15/19         | 17/19         | 0.660<sup>c</sup> |
| Non-housewife              | 4/19          | 2/19          |   |

<sup>a</sup>T-test, <sup>b</sup>Mann–Whitney U test, <sup>c</sup>Fisher’s Exact test, <sup>d</sup>Kolmogorov–Smirnov test

Numerical data with normal distribution are presented as mean (standard deviation). Numerical data with abnormal distribution are presented as median (minimum–maximum). Categorical data are presented as frequency/total.
Table 2. First time of requesting morphine (minutes).

| Group           | n  | Median (min–max) | p value |
|-----------------|----|------------------|---------|
| Electroacupuncture | 19 | 205 (20–1440)   | 0.001*  |
| Control         | 19 | 60 (30–270)      |         |

* Mann–Whitney U Test; *p<0.05

The median time of the first use of morphine in the EA group was 205 min with a minimum value of 20 and a maximum value of 1440, whereas that of the control group was 60 min with a minimum value of 30 and a maximum value of 270 (Table 2).

Table 3. Total respondents according to the first time of requesting morphine.

| Time (minutes) | Electroacupuncture (n = 19) | Control (n = 19) |
|----------------|-----------------------------|------------------|
| 0–60           | 4                           | 14               |
| 61–120         | 4                           | 4                |
| 121–480        | 7                           | 1                |
| >480           | 4                           | 0                |

In Table 3, most of the patients in the control group (n = 14) needed morphine within the first 60 min, whereas only four respondents from the EA group needed morphine.

Table 4. Total doses of morphine (mg) within 24 h after surgery.

| Group           | n  | Median (min–max) | p value |
|-----------------|----|------------------|---------|
| Electroacupuncture | 19 | 4.5 (0–19.5)    | 0.001*  |
| Control         | 19 | 15 (7.5–19.5)   |         |

* Mann–Whitney U test; *p<0.05

The median amount of post-operative morphine consumption in the EA groups was 4.5 with a minimum value of 0 and a maximum value of 19.5, whereas that of the control group was 15 with a minimum value of 7.5 and a maximum value of 19.5 (Table 4).

Table 5. Total number of respondents in terms of the total doses of morphine (mg) within 24 h.

| Morphine doses (mg) | Electroacupuncture (n = 19) | Control (n = 19) |
|---------------------|-----------------------------|------------------|
Table 5 shows that most of the participants in the EA group (n = 14) consumed approximately 0–6 mg of morphine, whereas most participants in the control group (n = 11) used 15–19.5 mg of morphine.

Table 6. Case record distribution of the side effects of morphine.

| Side effects of morphine   | Electroacupuncture (n = 19) | Control (n = 19) |
|----------------------------|-----------------------------|-----------------|
| Dizziness                  | None                        | None            |
| Nausea and vomiting        | None                        | 1               |
| Itchy                      | None                        | None            |
| Lain-lain                  | None                        | None            |

One patient from the control group experienced nausea and vomiting. Meanwhile, the patients in the EA group did not present with any side effects (Table 6).

4. Discussion

In this study, acupuncture points were chosen based on evidence-based medicine where all the points that were used had analgesic effects. Park et al. have suggested that low-frequency EA stimulation using ST36 points reduces allodynia pain where the effect is mediated by the spinal receptors GABA and GABA in mice [7]. Furthermore, Setiawardhani L et al. have shown that low-frequency EA at LI 4 point in healthy individuals led to a significant increase in plasma β-endorphins [8]. Another study investigated the analgesic effects of acupuncture and suggested that acupuncture at the Hegu LI4 and Zusanli ST36 points may increase the mean pain threshold to approximately 80%–90%, which is similar to that of the morphine group. Furthermore, acupuncture can gradually increase the pain threshold, and it can peak at 20–40 min [9]. Other studies have shown that EA with a frequency of 2 Hz, but not 100 Hz, at the Zusanli ST36 and Sanyinjiao SP6 points can induce the release of endorphins and neuropeptides that have analgesic effects [10]. Moreover, Huang et al. have proven that the use of 2 Hz EA at both points releases endorphins 1 and 2 in the brain of mice that interact with μ receptors to produce analgesic effects [11]. Wu et al. have shown that manual acupuncture and EA at the Zusanli ST36 point can increase enkephalins and β endorphins in the brain [12], and Jin et al. have shown that acupuncture at the same point may increase serotonin levels [13]. Meanwhile, Taichong LR3 is empirically used for lower abdominal and gynaecology post-operative pain [14]. Other studies by Han have proven that the release of endogenous opioids in the brain depends on the frequency of EA stimulation. Fei et al. have found that low-frequency EA stimulation (2 Hz) would release meth-encephalines and β endorphins in the spinal cord of mice. In humans, EA stimulation of the hands and feet causes a 367% increase in meth-encephalines but not dynorphins in the cerebrospinal fluid. In contrast, high-frequency EA (100 Hz) increases the release of dynorphins in the spinal cord of mice [12].

The characteristics of the participants did not differ between the two groups. Variables such as age, systolic and diastolic blood pressure, pulse rate, type of emergency or elective surgery, health status
according to ASA, education and occupation of respondents were used in the present study. The tabulation of the variables prior to therapy between the two groups is useful because this study is a clinical trial and is still recommended because randomisation did not guarantee that both groups will have the same characteristics [15].

Data distribution in this study was abnormal. The median times that the EA and control groups requested for morphine for the first time after caesarean section were 205 (20–1440) and 60 (30–270) min. The maximum value in the EA group was significantly high because there were four respondents who did not press the PCA button at all until the observation time limit was completed, i.e. up to 24 h or 1440 min. The minimum value of the EA group was 20 min, which was observed in one participant, whereas that of the control group was 30 min, which was observed in four respondents. The mean value of the EA group was 461.7 min and that of the control group was 69.2 min. Thus, there is a difference of 392 min or 6.5 h in both groups. EA can delay the first use of morphine up to 392 min (p = 0.001).

EA can also reduce the use of morphine where the median of the total dose of post-operative morphine in the EA group was 4.5 (0–19.5), whereas that of the control group was 15 (7.5–19.5). Based on the mean value, the mean of the EA group was 6.15, and that of the control group was 14.4. This result indicates that the EA group can save 8.25 mg or 42% of morphine compared with the control group and even higher dose compared with the result of a study conducted by Wu et al., in which 30% of morphine was saved. Mann–Whitney U test was performed and a p-value of 0.000 was obtained.

In the EA group, one respondent pressed the PCA button within 20 min, which was significantly fast. However, only 6 mg of morphine was used, which is equal to the average value of the group. Furthermore, one respondent used 19.5 mg of morphine, which is quite. However, it was first used within the first 60 min (100 min). This may be due to the variations in the therapy response of the respondents, or it may also be due to the extent of the surgical wound and the duration of surgery, although they were not recorded in this study.

One patient from the control group presented with nausea and vomiting and patients from the EA group did not experience any side effects, which were attributed to the direct stimulation in the chemoreceptor trigger zone on the fourth ventricle because morphine acts as a partial dopamine agonist at the dopamine receptors in the chemoreceptor trigger zone [16]. The working mechanism of EA in this study is segmental and central, and the results showed that the local mechanism does not play a role probably because local points were not used in this study. The mechanism of EA is significantly associated with the neural pathways. EA with a certain frequency and intensity will generate depolarisation and action potentials that extend by innervation to the dorsal horn of the spinal cord and supraspinal area. EA will stimulate the secretion of neurotransmitters and hormones such as serotonin and endorphins that play a role in the inhibition of pathological pain impulses [17].

EA with a sufficient intensity can stimulate the nerve fibres Aβ and Aδ that cause analgesic effects. Several nuclei in the brain that form circuits are involved in the process of acupuncture analgesia, including the nucleus raphe magnus (NRM), periaqueductal grey (PAG), locus coeruleus, preoptic area, nucleus submedius, habenular nucleus, nucleus accumbens, caudate nucleus and amygdala. Acupuncture analgesia is a manifestation of an integrated process at various levels in the central nervous system between the impulses in the painful area and acupuncture point [18]. Some clinical observations and experimental studies have shown that acupuncture signal pathways form a braid with pain lines. Then, impulse encounters are derived from the pain area, and acupuncture points meet in the dorsal horn of the spinal cord and medial thalamus where the integration of these two impulses occurs, e.g. axons from the caudate nucleus (Cd). Next, the NRM projects pain in the neurons in the parafascicular nucleus (Nf). The activation of Cd and NRM neurons by EA will significantly inhibit the nociceptive response in Nf that results in analgesic effects [18].
The duration of EA stimulation in this study was 30 min. However, it usually takes 20–40 min to reach the highest pain threshold. Clinically, the interval for EA analgesia therapy is 1 day, or it can be administered twice a week. However, in this study, EA was performed only once, and the effect was observed within 24 h. The modification of the EA stimulation time will not produce a better analgesic effect [12]. EA stimulation and PCA installation in this study were performed after the patient had complete motor regression (Bromage score of 0), and in general, EA is performed after 30 min to 1 h after surgery.

The present study has several limitations. First, the VA values were not measured because pain is a subjective perception. Moreover, the measurement of VAS may cause bias and it is unethical if there were respondents with high VAS values during the assessment. VAS is subjective because the respondent’s perception may have a bias towards the previous VAS value of pain if the VAS value was assessed periodically and the effect of the analgesics was obtained by the respondent before the next VAS assessment. Based on this result, the measured variables were the amount of morphine used within 24 h and the time required to push the PCA button for the first time by the respondent. The morphine dose and usage time are parameters that can be used to assess the effect of EA and to identify the pain level of the participants because the respondents will use morphine by independently pressing the PCA button if he/she feels pain.

Second, the respondents did not undergo preliminary prick tests and deep breathing exercises. The explanations were not adequate, and pre-surgery medications were not administered because the participants’ condition needed immediate surgery.

In some institutions, individuals with acute post-caesarean section pain were managed with either the use of opioid administered intravenously via PCA or neuraxial analgesics, and it is often provided together with a combination of non-steroidal anti-inflammatory drugs as multimodal therapy to reduce the side effects of each class of drug, which is attributed to the combination therapy that consists small doses of each drug [19]. Given that the goal of pain management is to relieve pain and reduce the side effects of various drugs, such as nausea, vomiting and gastrointestinal disturbances [20], acupuncture can be an option for managing pain because of its analgesic effects and the side effects are relatively safe [21].

5. Conclusion
The combination therapy of EA and PCA for post-caesarean section pain has good analgesic effects with a median number of post-operative morphine doses within 24 h and a lower median time of the first morphine dose.

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