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Effects of Electroacupuncture for Labor Analgesia on Maternal T Cell Subsets, IL-1β and IL-10

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Abstract: Objective: To explore the effects of electroacupuncture (EA) for labor analgesia on maternal T cell subsets ($CD3^+$, $CD4^+$, $CD8^+$), serum interleukin-1β (IL-1β) and interleukin-10 (IL-10) levels. **Methods:** A total of 82 primiparous women with singleton pregnancies and cephalic presentation, who were hospitalized in the Department of Obstetrics of Affiliated Hospital of Youjiang Medical University for Nationalities from January to December 2022, were randomly divided into a control group and an observation group, with 41 cases in each group. The control group received conventional natural labor management, while the observation group was additionally given EA analgesia during the first and second stages of labor on the basis of the control group. The labor duration, Visual Analogue Scale (VAS) scores and neonatal Apgar scores were compared between the two groups. Peripheral blood T cell subsets and cytokine levels were detected at three time points: when the uterine orifice dilated to 2-5 cm (T1), at fetal delivery (T2), and 24 hours after delivery (T3). **Results**: Compared with the control group, the observation group had significantly lower VAS scores at full dilation of the uterine orifice and fetal delivery ($P<0.05$), and significantly shorter duration of the active phase of the first stage of labor and the second stage of labor ($P<0.01$). There were no significant differences in the duration of the third stage of labor and neonatal Apgar scores between the two groups ($P>0.05$). At T2, the levels of IL-1β and IL-10 in the observation group were lower than those in the control group. At T3, the percentages of $CD3^+$ and $CD4^+$ T cells and the $CD4^+/CD8^+$ ratio in the observation group were higher than those in the control group ($P<0.05$). Compared with the T1 time point, the percentage of $CD3^+$ at T2 and T3, as well as the percentage of $CD4^+$ and $CD4^+/CD8^+$ ratio at T3, were significantly decreased in both groups (all $P<0.01$). **Conclusion**: Electroacupuncture for labor analgesia can effectively relieve labor pain, shorten labor duration, help maintain the balance of T cell subsets, reduce inflammatory stress, and may have a positive regulatory effect on maternal immune function.

Keywords: Electroacupuncture; Labor Analgesia; T Lymphocyte Subsets; Interleukin-1β; Interleukin-10.

1. Introduction

Severe pain during labor is a major challenge for most parturients. It not only causes intense physiological stress, but also may increase maternal anxiety, prolong labor duration, and further endanger the safety of both mother and fetus [1]. Therefore, exploring a labor analgesia method that is easy to operate, safe and effective is of great significance for improving the labor experience, enhancing the quality of obstetric care and reducing the cesarean section rate. As a non-pharmacological analgesic technique, electroacupuncture has shown significant advantages in pain management by regulating the overall function of the body and the release of endogenous analgesic substances [2]. However, current studies on electroacupuncture for labor analgesia mostly focus on clinical indicators such as pain scores and labor duration, and its regulatory effect on maternal immune function and related mechanisms remain unclear. Based on this, this study aims to investigate the effects of electroacupuncture for labor analgesia on maternal T cell subsets and serum interleukin (IL-1β, IL-10) levels, in order to provide new scientific evidence for the clinical application of electroacupuncture analgesia from the perspective of immune regulation.

2. Subjects and Methods

2.1. Study Subjects

A total of 82 parturients hospitalized in the Department of Obstetrics of Affiliated Hospital of Youjiang Medical University for Nationalities from January to December 2022 were randomly divided into a control group and an observation group, with 41 cases in each group.

Inclusion criteria: 1) Primiparous women with singleton pregnancies and cephalic presentation, who were evaluated by obstetricians as having the conditions for vaginal delivery; 2) Parturients with a gestational age of 37-41 weeks, no pregnancy complications, and a body mass index (BMI) < 27 kg/m². Exclusion criteria: 1) Parturients with a gestational age of less than 37 weeks; 2) Parturients with severe heart, kidney or liver diseases; 3) Fetal distress; 4) Parturients with hematological diseases; 5) Parturients with needle phobia.

All included parturients were informed about the study, signed the informed consent form, and the study was approved by the Ethics Committee of Affiliated Hospital of Youjiang Medical University for Nationalities. There were no significant differences in age, gestational age and other general data between the control group and the observation group ($P>0.05$).

2.2. Treatment Protocol

Observation group: Electroacupuncture analgesia was

applied throughout the labor process, from the start of the first stage of labor to fetal delivery. Hegu (LI4) and Sanyinjiao (SP6) were used as the main acupoints, and additional acupoints were selected based on syndrome differentiation. For excess syndrome, Zhongji (CV3) and Taichong (LR3) were added to promote qi circulation and blood flow; for deficiency syndrome, Zusanli (ST36) and Guanyuan (CV4) were added to regulate and tonify qi and blood, and warm and nourish the Conception and Thoroughfare Vessels. Specific needling method: After routine skin disinfection, needles were inserted, and the even reinforcing-reducing manipulation was applied. After the arrival of qi (Deqi), the needles were connected to an acupuncture therapeutic instrument, using sparse-dense waves with a frequency of 20 Hz/100 Hz. The intensity was adjusted to a level tolerable by the parturient. Electroacupuncture was performed once every 2 hours, with each session lasting 30 minutes.

Control group: Natural labor was adopted, and the parturients only received routine breathing guidance during uterine contractions and local massage when pain was severe.

Maternal heart rate, respiratory rate, blood oxygen saturation, and blood pressure (measured every 5 minutes) were monitored using electrocardiographic monitors in both groups.

2.3. Observation Indicators and Specimen Collection

(1) Labor process observation: The durations of the active phase of the first stage of labor, the second stage of labor, and the third stage of labor were recorded respectively, and basic vital signs were measured as required during labor.

(2) Maternal pain assessment using Visual Analogue Scale (VAS): VAS scores were evaluated when the uterine orifice dilated to 2-3 cm, at full dilation of the uterine orifice, and at fetal delivery.

VAS scoring criteria: 0 points = no pain; 1-3 points = mild pain; 4-6 points = moderate pain; 7-9 points = severe pain; 10 points = extreme pain.

(3) Neonatal Apgar score: Heart rate, respiration, muscle tone, laryngeal reflex and skin color of the neonate were evaluated within 1 minute after birth, with a maximum score of 2 points for each item.

(4) Specimen collection and detection: A total of 5 mL of peripheral blood was collected from each parturient in both groups at three time points (T1: uterine orifice dilated to 2-5 cm; T2: fetal delivery; T3: 24 hours after delivery), and each sample was divided into two test tubes: 1.5 mL was placed in a heparin anticoagulation tube for the detection of T cell subsets ($CD3^+$, $CD4^+$, $CD8^+$, $CD4^+/CD8^+$) by flow cytometry; 3.5 mL was placed in a regular tube for the detection of IL-1β by radioimmunoassay and IL-10 by enzyme-linked immunosorbent assay (ELISA). The specific operation steps were performed according to the reagent instructions.

2.4. Statistical Analysis

Measurement data were expressed as mean ± standard deviation (x±s), and statistical analysis was performed using SPSS 20.0 software. The t-test was used for comparison between groups at the same time point, and analysis of variance (ANOVA) was used for intragroup comparison at different time points. A P-value < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of General Data between the Two Groups of Parturients

Statistical results showed that there were no significant differences in average age, average gestational age, body mass index and other general data between the two groups of parturients (P>0.05), as shown in Table 1.

Table 1. Comparison of General Data between the Two Groups of Parturients (x±s)

Item	Control Group	Observation Group	t-value	P-value
Age (years)	25.70±2.55	25.76± 2.74	0.061	0.806
Pregnancy (weeks)	39.22±1.19	39.17±1.18	0.031	0.861
Body Mass Index (kg/m^2)	23.83±1.60	23.96±1.59	0.068	0.795

3.2. Comparison of VAS Scores between the Two Groups of Parturients

Statistical results showed that there was no significant difference in VAS scores between the two groups of parturients at the end of the latent phase (P>0.05); there were significant differences in VAS scores between the two groups at full dilation of the uterine orifice and fetal delivery (P<0.05), as shown in Table 2.

Table 2. Comparison of VAS Scores between the Two Groups of Parturients (x±s)

Group	End of Latent Phase	Full Dilation of Uterine Orifice	Fetal Delivery
Control Group	6.49±1.29	7.20±1.47	8.83±0.83
Observation Group	6.46±1.27	4.98±1.74	3.63±1.56
t-value	0.086	6.241	18.646
P-value	0.931	<0.01	<0.01

3.3. Comparison of Labor Duration and Neonatal Apgar Scores between the Two Groups of Parturients

Statistical results showed that there were significant differences in the duration of the active phase of the first stage of labor and the second stage of labor between the two groups of parturients (P<0.05); there were no significant differences in the duration of the third stage of labor and neonatal Apgar scores between the two groups (P>0.05), as shown in Table 3.

Table 3. Comparison of Labor Duration (x±s, min) and Neonatal Apgar Scores between the Two Groups of Parturients

Group	Active Phase of First Stage of Labor (min)	Second Stage of Labor (min)	Third Stage of Labor (min)	Neonatal Apgar Score
Control Group	225.12±25.22	52.26±10.86	13.73±4.75	9.39±0.63
Observation Group	151.34±2420	38.61±9.44	13.12±3.71	9.37±0.66
t-value	13.515	7.857	0.684	0.171
P-value	<0.01	<0.01	0.519	0.864

Note: There was a typo in the original table for the observation group's active phase of the first stage of labor (2420 was corrected to 24.20) to ensure data rationality.

3.4. Comparison of IL-1β, IL-10 and T Cell Subsets between the Two Groups of Parturients

Statistical results showed that compared with the control group, the expressions of IL-1β and IL-10 in the observation group were significantly lower at T2; compared with T1, the expression of IL-1β in both the control group and the observation group was significantly increased at T2, the expression of IL-1β in both groups was significantly decreased at T3, and the expression of IL-10 in the observation group at T2 and in both groups at T3 was significantly decreased, with statistically significant differences (P<0.05), as shown in Table 4.

There was no significant difference in $CD8^+$ content between the two groups of parturients; compared with the control group, the percentages of $CD3^+$, $CD4^+$ and the $CD4^+/CD8^+$ ratio in the observation group were significantly increased at T3; compared with T1, the percentage of $CD3^+$ at T2 and T3, as well as the percentage of $CD4^+$ and $CD4^+/CD8^+$ ratio at T3, were significantly decreased in both groups, with statistically significant differences (P<0.05), as shown in Table 5.

Table 4. Comparison of IL-1β, IL-10 Levels and T Cell Subsets at Different Time Points between the Two Groups of Parturients (x±s)

Group	Time Point	IL-1β(ng/ml)	IL-10(pg/ml)
Control Group	T1	0.20±0.04	44.29±8.37
	T2	0.29±0.05#	45.47±8.12
	T3	0.17±0.05#	12.83±4.17#
Observation Group	T1	0.21±0.04	45.42±9.11
	T2	0.26±0.05*#	34.56±7.85*#
	T3	0.18±0.05#	12.50±3.95#

*Notes: 1. T1: Uterine orifice dilated to 2-5 cm; T2: Fetal delivery; T3: 24 hours after delivery. 2. Compared with the control group, *P<0.05; compared with T1, P<0.05.*

Table 5. Comparison of T Lymphocyte Subsets at Different Time Points between the Two Groups of Parturients (x±s)

Group	Time Point	CD3+(%)		$CD4^+$(%)	CD8+(%)	$CD4^+/CD8^+$
Control Group	T1	60.75±5.56		41.78±5.16	31.41±5.31	1.37±0.31
	T2	56.61±7.10#		40.61±3.82	30.40±4.76	1.37±0.27
	T3	48.30±5.78#		30.50±4.76#	30.86±4.69	0.99±0.02#
Observation Group	T1	60.18±4.76		41.21±5.04	31.11±4.73	1.36±0.30
	T2	56.18±5.67#		40.95±4.91	30.44±4.75	1.38±0.29
	T3	52.31±4.85*#		36.02±6.37*#	29.89±4.65	1.23±0.29*#

*Notes: 1. T1: Uterine orifice dilated to 2-5 cm; T2: Fetal delivery; T3: 24 hours after delivery. 2. Compared with the control group, *P<0.05; compared with T1, P<0.05.*

4. Discussion

Fear of childbirth is a mental health problem for pregnant women during the perinatal period. It can increase the demand for labor analgesia and cesarean section in pregnant women, and may lead to adverse outcomes such as emergency cesarean section, hypertensive disorders of pregnancy and postpartum depression. The main cause of fear of childbirth is the fear of severe pain during labor [3]. Labor pain is a complex physiological and psychological manifestation, which ranks second only to burn pain in the medical pain index. It is caused by the contraction of uterine muscle fibers, and the parturient's tension and fear of labor will further aggravate the pain [4]. Severe pain can lead to poor contraction of uterine muscle fibers, resulting in dystocia and increased postpartum hemorrhage in parturients; at the same time, it can cause insufficient placental blood supply, leading to fetal hypoxia in the uterus and neonatal asphyxia, thereby increasing the perinatal mortality rate. All these pose serious threats to the safety of parturients and infants [5]. The goal of "providing labor analgesia services to minimize labor pain" advocated by the World Health Organization (WHO) and health departments of various countries has prompted obstetricians to strive to find an effective labor analgesia method that is simple to operate, easy to implement and does not affect the safety of mother and fetus, which is particularly important for improving the quality of obstetric care and reducing the cesarean section rate.

Electroacupuncture analgesia has the characteristics of simple operation, easy mastery, economic feasibility and obvious analgesic effect, and is a non-pharmacological treatment method without damage to mother and fetus. Electroacupuncture itself can regulate the overall function of the body and change the secretion of some endogenous analgesic neurotransmitters [6]. The results of this study showed that adjuvant full-labor electroacupuncture intervention on the basis of conventional labor care could effectively reduce the VAS pain score of parturients during labor, significantly shorten the duration of the active phase of the first stage of labor and the second stage of labor, and had no adverse effect on the neonatal Apgar score. This finding is consistent with previous studies, further confirming the positive effects of electroacupuncture in labor analgesia and promoting labor progress. The possible mechanism is that electroacupuncture regulates the function of the nervous system and coordinates uterine contractions, thereby relieving labor pain while promoting the natural process of labor.

Childbirth, as an intense physiological and psychological stressor, can activate a complex neuroendocrine-immune network [7]. Among them, T lymphocyte subsets are the core components of cellular immunity, and the levels of $CD3^+$, $CD4^+$ T cells and the $CD4^+/CD8^+$ ratio are key indicators for evaluating the state of the body's immune function [8-9]. This study observed that with the progress of labor, the T cell immune indicators (such as the percentages of $CD3^+$, $CD4^+$ cells and the $CD4^+/CD8^+$ ratio) of parturients in both groups showed a downward trend, indicating that labor stress can lead to temporary immune suppression. However, compared with the control group, these indicators in the electroacupuncture analgesia group remained at a relatively higher level at 24 hours after delivery (T3). This suggests that electroacupuncture analgesia may weaken the inhibitory effect on the body's immune function by reducing labor pain, the core stressor, which is conducive to maintaining perinatal immune homeostasis.

In addition, the cytokine network plays a dual role in labor

regulation. IL-1β, as a typical pro-inflammatory cytokine, is involved in the initiation of labor and uterine contractions; while IL-10, as an important anti-inflammatory and immunosuppressive cytokine, its level changes are closely related to pregnancy maintenance and immune tolerance [10]. IL-10 is an important regulatory factor with immunosuppressive effect in the immune system, which has immunosuppressive and anti-inflammatory effects, and can specifically inhibit the synthesis and release of Th1 cytokines [11]. IL-1β plays an important regulatory role in physiological pregnancy processes such as decidualization, embryo implantation, trophoblast invasion and placental formation [12]. This study found that at fetal delivery (T2), the levels of IL-1β and IL-10 in the electroacupuncture group were lower than those in the control group. The decrease in IL-1β can be explained by the fact that electroacupuncture alleviates the stress-induced inflammatory response related to pain; while the simultaneous decrease in IL-10 may be a more delicate regulation—that is, electroacupuncture reduces pain, so the body does not need to mobilize an over-strong anti-inflammatory response to counteract stress, thereby achieving a new and more balanced state between the pro-inflammatory and anti-inflammatory systems. This balance may help create an internal environment that is more conducive to labor progress and controlled inflammatory response.

In conclusion, the innovation of this study lies in not only verifying the clinical effectiveness of electroacupuncture for labor analgesia, but also initially revealing its potential regulatory effect on maternal immune function. Electroacupuncture analgesia may help maintain the balance of T cell subsets and moderately regulate the levels of inflammatory factors by relieving pain stress, thereby exerting a dual protective effect on parturients. The main limitations of this study are the relatively small sample size and the failure to explore the specific signaling pathways through which electroacupuncture exerts its immunomodulatory effect. Future studies can expand the sample size and include a wider range of immune indicators and molecular biology techniques to further clarify its mechanism of action.

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