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CLINICAL STUDY

Effect of direct current pulse stimulating acupoints of JiaJi (T10-L3) and Ciliao (BL 32) with Han's Acupoint Nerve Stimulator on labour pain in women: a randomized controlled clinical study

Liu Ye, Xu Mingjun, Che Xiangming, He Junqin, Guo Dandan, Zhao Guosheng, Zhang Guogang, Zhang Shuo, Kang Kai, Zhang Chunlei, Wang Yinan, Li Shan, Zhang Qinglin, Xu Li, Zhang Ming, Han Bin, Jing Yumiao, Zhang Ning

Liu Ye, Xu Mingjun, Che Xiangming, Guo Dandan, Zhao Guosheng, Zhang Guogang, Zhang Shuo, Kang Kai, Zhang Chunlei, Wang Yinan, Li Shan, Zhang Qinglin, Xu Li, Zhang Ming, Han Bin, Jing Yumiao, Zhang Ning, Department of Anesthesiology, Beijing Obstetrics and Gynecology Hospital Affiliated to Capital Medical University, Beijing 100026, China

He Junqin, Department of Traditional Chinese Medicine, Beijing Obstetrics and Gynecology Hospital Affiliated to Capital Medical University, Beijing 100026, China

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Correspondence to: Prof. Xu Mingjun, Department of Anesthesiology Beijing Obstetrics and Gynecology Hospital Affiliated to Capital Medical University, Beijing 100026, China.
snake6502@163.com

Telephone: +86-10-52273823; +86-13810545377

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Abstract

OBJECTIVE: To assess the clinical effect and safety of direct current (DC) pulse produced by Han's Acupoint Nerve Stimulator in reduction (HANS) of labor pain.

METHODS: Totally 120 participants were enrolled in this clinical trial, and were randomly divided into 4 groups including: HANS group, patient controlled intravenous analgesia (PCIA) group, patient-controlled epidural analgesia (PCEA) group and control group. The HANS group was treated by stimulating the acupoints of JiaJi (T10-L3) and Ciliao (BL 32) with DC pulse of 100 Hz and 15-30 mA produced by a portable battery-powered Han's Acupoint Nerve Stimulator for 30 min. The PCIA group was intravenously infused Ondansetron (8 mg) for 5 min, then tramadol injection (1.5 mg/kg) was slowly dripped by using BaxterAP Ⅱ electronic pump with 50 mL tramadol (0.70%) + ondansetron (8 mg), background infusion 2 mL/h, PCA dose of 2 mL, lockout interval of 10 min. In PCEA group, women received intrathecal injection ropivacaine (3 mg) in L2-3, and epidural catheter was connected to BaxterAP Ⅱ electronic pump, with 100 mL Ropivacaine (0.1%) and Sufentanil (50 ug), background infusion 5 mL, Patient controlled analgesia (PCA) dose of 5 mL, lockout interval of 10 min. The control group was not received analgesia. The visual analogue scale (VAS), stage and manner of labor, Apgar score of newborn, neonatal weights, oxytocin dosage, postpartum hemorrhage and side effects were monitored in all groups.

RESULTS: The vital signs were all stable in the four analgesic groups. After analgesia, there was statistical difference in VAS score between HANS group and control group, between PCEA group and the control group, between PCIA group and control group. The analgesic effect in the PCEA group was significantly better than that of other two groups. The second stage of labor in the PCEA group was longer than the other three groups, showing significant difference between them. The Apgar score of newborn 1min after birth in the PCIA group was slightly lower than that of the other two groups, showing significant difference between them. The neonatal weights between four groups were not significantly different. The rate of cesarean section

in the control group was significantly higher than that of the labor analgesia group, there was statistically difference in four groups. The number of PCIA group that used oxytocin was lower than that of other three groups. There was no significant difference in postpartum hemorrhage between four groups. The side effects of the PCEA group were itching, uroschesis and neonatal asphyxia and PCIA group were nausea and vomiting and neonatal asphyxia. However, fewer side effects were observed in the HANS group.

CONCLUSION: The DC pulse produced by HANS may be a non-pharmacological alternative to labor pain with fewer side effects.

Key words: Analgesia, patient-controlled; Analgesia, epidural; Anesthesia; Combined spinal and epidural block; The Han's Acupoint Nerve Stimulator; Randomized controlled trial

INTRODUCTION

Currently the women giving birth account for 21% married women, about 280 million in China.[1] During labor process, women will suffer severe labor pain, which inevitably lead to tension, vascular spasm, uncoordinated contraction of the uterus. If serious, it will also cause severe fetal hypoxia, blocked stage of labor and even threaten maternal and child safety.

Labor analgesia could not only relieve labor pains, but also improve the maternal and child health and decrease the cesarean section rate.[2] In 1847, a British obstetrician, Tames Simpson, firstly used Ether in labor analgesia. Since then, people continually investigated how to make a woman safely give birth in a sober, no-pain state.[3] Presently, there are two types of labor analgesia methods: non-drug analgesia and drug-induced analgesia. The non-drug analgesia mainly includes the mental prevention analgesia, Lamaze's method, accompanying labor, acupuncture analgesia, transcutaneous electrical stimulation analgesia.[4] The drug-induced analgesia contains Opioids, Tramadol hydrochloride and Pethidine. Although narcotic analgesic are commonly used in clinics, their applicaition are also limited because of contraindications and side effects.[5] Many studies demonstrated that Han's Acupoint Nerve Stimulator can decrease labor pain during the labor process by peripheral electrical stimulation, which might lead to release of opioid peptides in central nervous system.[6] Although Han's Acupoint Nerve Stimulator was effective for labor relief, the study to compare its effectiveness with other methods was seldom reported.

In this study, we aimed to evaluate the effect and safety of direct current (DC) pulse generated by Han's acupoint nerve stimulator (HANS) to reduce labor pain.

MATERIALS AND METHODS

Subjects

Our study recruited participants between August 2010 and November 2013. Totally 120 participants were enrolled in this clinical trial. They were from Beijing Obstetrics and Gynecology Hospital. The age was 20-29 year old. The study was approved by the research ethics committee of the Beijing Obstetrics and Gynecology Hospital. After an explanation of the study procedures, each participant signed informed consent form. Active phase was confirmed and diameters of cervical dilatation were determined by the obstetrical personnel.

Inclusion criteria

The inclusion criteria were: (a) no previous poor obstetrical outcome; (b) no experience in Han's Acupoint Nerve Stimulator and TENS for other reasons; (c) term pregnancy (> 37 weeks of gestation); (d) at active phase of the first stage of labor with cervical dilatation 3 cm.

Exclusion criteria

Patients were excluded if they: (a) had the history of experimental drug allergy; (b) had been diagnosed with other diseases such as preoperative presence of maternal mental, neurological diseases, affecting evaluation of pains and disease conditions; (c) had combined with gestational hypertension, gestational diabetes, gestational thyroid diseases; (d) had taken analgesic drugs or with a history of long-term use of analgesic drugs; (e) had used diazepam, piperazine hydrochloride or other sedative, analgesic drugs in the stages of labor; (f) were overweight or low pregnancy weight,body mass index (BMI)< 18.5 or BMI > 25 kg/m^2; (g) were not agree to receive painless labor and not sign the informed consent from.

Treatment

The control group was not received analgesia. The HANS group received DC pulse stimulus at acupounts of Jiaji points (T 10-L 3) and Ciliao (BL 32)The stimulus was 100 Hz with a burst frequency of 2 Hz (dense-dispersed waveform) The intensity was 15-30 mA. The pulse duration was used for 30 min. Women in the PCIA group were intravenously infused ondansetron 8 mg; 5 min later, 1.5 mg/kg tramadol injection was slowly dripped, connected to Baxter AP Ⅱ electronic pump with 50 mL of 0.70% tramadol + ondansetron 8 mg, background infusion 2 mL/h, PCA dose of 2 mL, lockout interval of 10 min. patient-controlled epidural analgesia (PCEA) group: L2-3 combined spinal-epidural puncture, intrathecal injection of 3mg ropivacaine, epidural catheter connected to BaxterAP Ⅱ

electronic pump, with 100 mL 0.1% ropivacaine and 50 ug sufentanil, background infusion 5 mL, PCA dose of 5 mL, lockout interval of 10 min when the cervix was fully dilated (10 cm). All treatments were stopped at the point of complete cervical dilatation.

Outcome measures

The basic vital signs of the parturient (blood pressure, electrocardiograph, oxygen saturation, respiration) were measured. The pain intensity was measured with visual analogue scale (VAS): from 1 (no pain) to 10 (the most painful). Participants were asked by study personnel to estimate how painful during the last contraction before the application of analgesia. The VAS was recorded at each application (30 and 60 min after analgesia, cervical dilatation to 7-8 cm, the end of the first stage). The labor time, labor mode, delivery rate, oxytocin dosage, postpartum hemorrhage side effects were observed. The birth-weight was recorded after delivery. Neonatal assessments were Apgar score at 1 and 5 min after birth.

Statistical analysis

All the outcomes were expressed as mean ± standard deviation ($\bar{x} \pm s$). Statistical analysis was undertaken using SPSS version 16.0 (International Business Machines Corporation, Armonk, NY, USA). Data among groups were compared using analysis of variance; (b) comparison of categorical data among four groups were analyzed by *Chi*-square test; (c) repeated measures analysis of variance were employed to analyze repeated measurement data; (d) least significant difference-*t* test was performed for comparison between groups. $P < 0.05$ was the significant level.

RESULTS

After enrollment, 120 participants were randomized into four groups according to a random number table method. There was no statistical difference in the basic information between four groups ($P > 0.05$, Table 1, Figure 1).

The vital signs were all stable in the three analgesic groups. The blood pressure of the parturient in the PCEA group 5 min and 15 min after analgesia were 110.5 ± 9.2 / 65.3 ± 4.2 mm Hg, and 112.1 ± 8.5 / 64.7 ± 5.6 mm Hg respectively, and the SBP and DBP decreased slightly, showing significant difference compared with those before analgesia ($P < 0.05$), In the PCIA group, the blood pressure decreased slightly at 15 min, showing no statistically significant difference ($P > 0.05$).

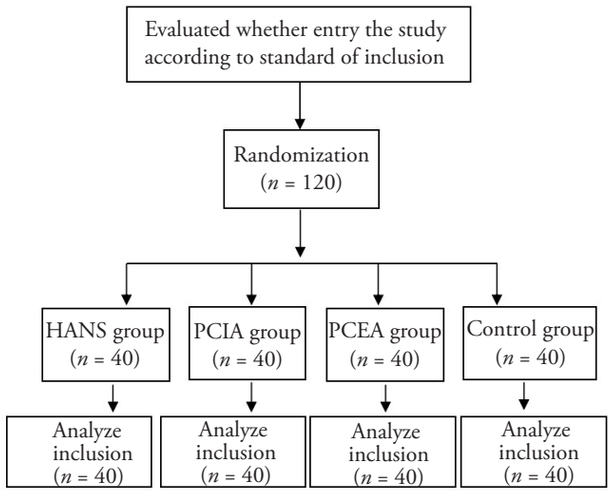

Figure 1 Flow diagram of the study

There was no significant difference in VAS score of the four groups of the parturient before analgesia ($P > 0.05$). After analgesia, there was statistical difference in VAS score between HANS group and control group ($P < 0.05$), between PCEA group and control group, between PCIA group and control group ($P < 0.05$). The analgesic effect in the PCEA group was significantly better than that of other two groups (Table 2).

The second stage of labor in the PCEA group was longer than the other three groups, showing significant difference between them. The Apgar score of newborn 1min after birth in the PCIA group was slightly lower than that of the other three groups, showing significant difference between them. The neonatal weights between four groups were not significantly different ($P > 0.05$, Table 3).

The rate of cesarean section in the control group was significantly higher than that of the labor analgesia group, There was statistically difference in four groups ($P < 0.01$).The number of PCIA group that used oxytocin was lower than that of other three groups ($P < 0.05$).There was no significant difference in postpartum hemorrhage between four groups ($P > 0.05$, Table 4).

Table 1 Parturient characteristics ($\bar{x} \pm s$)

Group	*n*	Age (years)	Gestational age (weeks)	Body height (cm)	Weight (kg)	Diameter of cervical (cm)
HANS	30	27.5±3.8	39.0±0.7	163.5±5.6	71.1±9.9	3.2±0.4
PCIA	30	28.3±4.0	39.1±0.8	161.2±5.4	72.1±10.3	3.2±0.4
PCEA	30	28.0±4.1	39.3±0.8	163.0±5.6	71.7±10.3	3.3±0.4
Control	30	26.6±3.8	39.0±0.8	162.7±5.6	72.1±10.3	3.3±0.4

Notes: HANS: the Han's acupoint nerve stimulator group; PCIA: patient-controlled intravenous analgesia group; PCEA: patient-controlled epidural analgesia group. Patients in the HANS group were treated with Han's acupoint nerve stimulator; patients in the PCIA group were treated with patient-controlled intravenous analgesia; patients in the PCEA group were treated with patient-controlled epidural analgesia; patients in the control group were not received analgesia.

The side effects in the HANS group were neonatal asphyxia, and the complication rate was 6.67%. Side effects in the PCIA group were nausea and vomiting and neonatal asphyxia, while side effects in the PCEA group were itching, uroschesis and neonatal asphyxia. There were 2 cases of neonatal asphyxia in control group. There was significant difference in four groups ($P < 0.05$, Table 5).

DISCUSSION

Pregnancy and delivery is an important component of reproductive health. Over 90% of the parturient may have a strong anxiety, tension and even fear due to the severe labor pain.[7]

These negative stress may cause a series of neuroendocrine reactions, and lead to various functional and metabolic changes, such as increased heart rate, elevated blood pressure, hyperventilation and increased oxygen consumption.[8,9] The raise of cesarean section rate will lead to high risk of the surgical complications to the mother and child.[10] Therefore, creating a safe and painless delivery environment from the obstetric mode of 'improving quality of perinatal infant and implementing people-oriented' is an important research content of the perinatal medicine.[11]

In 1847, a British obstetrician, Tames Simpson, successfully completed the first case of labor analgesia operation in the world. After that, people has been developing a safe analgesic technique for years.[12] An ideal labor analgesia should have the following characteristics: (a): safety for mother and child; (b): rapid onset of drug administration, reliable action, to meet the need of the whole duration of labor; (c): avoid movement re-

Table 2 Comparison of VAS in four groups ($\bar{x} \pm s$)

Group	*n*	Before analgesia	30 min after	60 min after	Cer 7-8 cm	Cer 10 cm
HANS	30	95±12[a]	71±13[a]	65±12[a]	68±11[a]	60±13[a]
PCIA	30	94±10[a]	51±11[ab]	45±8[ab]	50±11[ab]	50±12[ab]
PCEA	30	95±10[a]	18±5[abc]	20±6[abc]	24±4[abc]	27±5[abc]
control	30	94±11	97±13	97±14	98±14	90±15

Notes: HANS: the Han's acupoint nerve stimulator group; PCIA: patient-controlled intravenous analgesia group; PCEA: patient-controlled epidural analgesia group. Patients in the HANS group were treated with Han's acupoint nerve stimulator; patients in the PCIA group were treated with patient-controlled intravenous analgesia; patients in the PCEA group were treated with patient-controlled epidural analgesia; patients in the control group were not received analgesia. Compared with control group, [a]$P < 0.05$; compared with HANS group, [b]$P < 0.05$; compared with PCIA group, [c]$P < 0.05$.

Table 3 Comparison of stage of labor, neonatal weight and Apgar score between four groups ($\bar{x} \pm s$)

Group	*n*	Stag of labor (min)			Apgar score		Neonatal weight (g)
		First	Second	Third	1 min	5 min	
HANS	30	430.1±119.8	43.3±17.5[a]	8.9±3.1	9.9±0.7[b]	9.9±0.9	3301.3±321.8
PCIA	30	425.2±198.7	45.9±22.5[a]	9.1±3.1	9.2±0.3	9.8±0.8	3275.5±263.3
PCEA	30	423.3±181.2	61.2±29.4	9.4±4.2	9.8±0.5[b]	9.9±0.7	3205.5±434.4
Control	30	439.6±200.3	46.3±20.6[a]	9.3±3.0	9.9±0.9[b]	9.9±0.8	3311.2±392.1

Notes: HANS: the Han's acupoint nerve stimulator group; PCIA: patient-controlled intravenous analgesia group; PCEA: patient-controlled epidural analgesia group. Patients in the HANS group were treated with Han's acupoint nerve stimulator; patients in the PCIA group were treated with patient-controlled intravenous analgesia; patients in the PCEA group were treated with patient-controlled epidural analgesia; patients in the control group were not received analgesia. Compared with PCEA group, [a]$P < 0.05$; compared with PCIA group, [b]$P < 0.05$.

Table 4 Comparison of delivery mode and use of oxytocin between four groups

Group	*n*	Natural labor	Instrumental delivery (*n*)	Cesarean section (*n*)	Use of oxytocin (*n*)	Postpartum hemorrhage (mL)
HANS	30	27[a]	2	1[a]	12[b]	126.5±22.9
PCIA	30	26[a]	2	2[a]	6	132.5±25.4
PCEA	30	26[a]	2	2[a]	13[b]	124.7±23.7
Control	30	20	2	8	14[b]	139.8±29.0

Notes: HANS: the Han's acupoint nerve stimulator group; PCIA: patient-controlled intravenous analgesia group; PCEA: patient-controlled epidural analgesia group. Patients in the HANS group were treated with Han's acupoint nerve stimulator; patients in the PCIA group were treated with patient-controlled intravenous analgesia; patients in the PCEA group were treated with patient-controlled epidural analgesia; patients in the control group were not received analgesia. Compared with control group, [a]$P < 0.05$; compared with PCIA group, [b]$P < 0.05$.

Table 5 Comparison of side effects between four groups

Group	*n*	Hypotension (*n*)	Itching (*n*)	Uroschesis (*n*)	Nausea and vomiting (*n*)	Neonatal asphyxia (*n*)	Complication rate (%)
HANS	30	0	0	0	0	2	6.7[ab]
PCIA	30	0	0	0	6	2	26.7
PCEA	30	1	1	1	0	1	13.3[a]
Control	30	0	0	0	0	2	6.7[ab]

Notes: HANS :the Han's acupoint nerve stimulator group; PCIA: patient-controlled intravenous analgesia group; PCEA: patient-controlled epidural analgesia group. Patients in the HANS group were treated with Han's acupoint nerve stimulator; patients in the PCIA group were treated with patient-controlled intravenous analgesia; patients in the PCEA group were treated with patient-controlled epidural analgesia; patients in the control group were not received analgesia. Compared with PCIA group, [a]$P < 0.05$; compared with PCEA group, [b]$P < 0.05$.

tardation, not affecting actions of the parturient's movements; (d): the parturient were sober in the whole delivery process; (e): meet the demand of surgery when necessary. Currently the popular analgesia method is patient-controlled epidural analgesia because of simple epidural analgesia, combined spinal and epidural block analgesia, continuous spinal anesthesia.[13] Presently, the spinal combing with epidural analgesia is the widely used.[14] The main drugs used in patient-controlled epidural analgesia are ropivacaine and opioids (sufentanil, fentanyl). The main pharmacological properties of ropivacaine is apparent separation of sensory and motor nerve blockade, especially the blocking and separating properties at a low-dose and low concentration. However, with the continuous development of new technologies, Spinocath catheter emerged, which could be used to continuous spinal analgesia with less invasion.[15] Zhang Ning *et al*. performed the labor analgesia at the latent period through continuous intrathecal injection, with the analgesia recipe of sufentanil 1 μg/mL. Compared with combined spinal and epidural analgesia group, there was no significant differences in labor duration, natural birth rate, analgesic satisfaction rate, and side effects such as itching, post-dural puncture headache between them., thus, the effect of labor analgesia by continuous intrathecal injection method was similar to that of combined spinal epidural analgesia.[16]

However, since PCEA had the characteristics of complicated operation, high requirements for operators and the parturient, it is not suitable for all the parturient. The reasons are following (a): PCEA is an invasive procedure, having such complications as intraspinal hematoma, abscess, spinal nerve injury, headache and waist and back pains after puncture, etc; (b): rapid duration of labor, missing the opportunity of epidural puncture; (c): parturient's fear of epidural puncture; (d): not suitable for epidural puncture (intraspinal diseases such as lumbar intervertebral disc herniation, history of lumbar spine surgery, back infection, blood clotting abnormalities, etc.; (e): puncture operation fails due to maternal obesity, etc.[17]

HANS has been used in China for more than 20 years. The use of HANS was introduced in 2002 as an effective approach for pain relief for the women in labor.[18] Traditionally, two pairs of electrodes are placed alongside the spine. These segments corresponded to the pathways of A fibres into the inhibitory circuits in the laminae of the dorsal horn of spinal cord. It concluded that high freguency (100 Hz) transcuraneous electric nerve stimulation can improve naloxone reversible and low frequency (2 Hz) improve the lever of endorphin and enkephalin *in vivo*. The frequency conversion can raise three alleviations *in vivo*. However, It can increases pain threshold by regulating the content of β-endorphin level in peripheral blood of the parturient.[19]

The HANS, Patient-controlled intravenous analgesia (PCIA) and PCEA are widely used in the treatment of labor pain. In this study, we aimed to observe therapeutic effects of three methods. However, no studies are reported. So we designed 4 groups to perform a randomized, control trial including HANS, PCIA, PCEA and control group The results indicated that the four groups were well matched in terms of mean pain intensity, but the VAS scores at 30, 60 min, cervical dilation 7-8 cm and 10 cm time points after treatment had extremely significant differences compared with that of control group ($P < 0.05$).VAS scores in PCEA group at each time point after beginning of treatment were lower than those in PCIA and HANS group ($P < 0.05$). At the same time, the mean VAS scores in HANS were all lower than that in the control group ($P < 0.05$).

Limitations of this study include its small size, the lack of fetal blood gas analysis, and uterine contraction. Further study should be conducted to investigated the effect of HANS plus h PCEA for labor analgesia. In conclusion, HANS can be a non-pharmacological analgesic therapy for labor pain with fewer side effects.

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