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OBSTETRICS

Transcutaneous electrical nerve stimulation at the PC-5 and PC-6 acupoints reduced the severity of hypotension after spinal anaesthesia in patients undergoing Caesarean section

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Background. Despite prophylactic measures, hypotension remains a common side-effect of spinal anaesthesia for parturients. Electroacupuncture at the Neiguan (PC-6) and Jianshi (PC-5) points influences haemodynamics. We thus hypothesized that transcutaneous electrical nerve stimulation (TENS) at traditionally used acupuncture points would reduce the severity of hypotension after spinal anaesthesia in patients undergoing Caesarean section.

Methods. After obtaining approval from the local ethics committee and written informed patient consent, 36 singleton parturients undergoing Caesarean section under spinal anaesthesia were randomized into three groups. The control group received no treatment, and the acupoint and non-acupoint groups received TENS at the PC-5 and PC-6 points of both arms and non-acupoints of both shoulders, respectively.

Results. The median (range) of the lowest recorded systolic blood pressure was significantly higher in the acupoint group compared with the other groups and that of the non-acupoint group was higher than that of the control group [control, 70 (68–82) mm Hg; acupoint, 94 (84–109) mm Hg; non-acupoint, 81 (70–92) mm Hg: $P<0.001$]. Significantly more parturients in the control and non-acupoint groups experienced hypotension [control, 10 (83%); acupoint, 4 (33%); non-acupoint, 10 (83%): $P=0.013$]. More ephedrine was required to maintain arterial blood pressure in the control and non-acupoint groups.

Conclusions. TENS on the traditional acupuncture points reduced the severity and incidence of hypotension after spinal anaesthesia in parturients.

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Hypotension after spinal anaesthesia for Caesarean section occurs commonly.[1–3] Prophylactic measures include fluid preload, lateral tilt, and the use of vasopressors.[1 3 4] Despite these prophylactic measures, hypotension has an incidence of up to 30–60% after spinal anaesthesia for parturients.[1–6]

Chinese acupuncture-based techniques have been used for perioperative management of anxiety,[7] postoperative nausea and vomiting,[8] and postoperative analgesia.[9] In animal studies, electroacupuncture at the Neiguan (PC-6) and Jianshi (PC-5) points influences vascular pressure responses and the cardiovascular sympathetic system,[10 11] and especially electroacupuncture at the PC-6 point increases cardiovascular variables such as stroke volume and cardiac output and alleviates haemorrhagic hypotension.[12 13]

We hypothesized that transcutaneous electrical nerve stimulation (TENS) at traditionally used acupuncture points would reduce the severity of hypotension after spinal anaesthesia in patients undergoing Caesarean section. Thus, the purpose of the present preliminary study was to test the effect of TENS at the PC-6 and PC-5 points on haemodynamics after spinal anaesthesia in patients undergoing Caesarean section.

Methods

After obtaining approval from the local ethics committee and written informed patient consent, 36 ASA I multigravida parturients carrying a singleton pregnancy at full-term gestation (38–39 weeks) and presenting for elective Caesarean section were enrolled in this randomized study. Parturients suffering from preeclampsia, hypertension, diabetes, or obesity (BMI>30 kg m^{-2}) were excluded.

Patients were randomized to three groups, using computer-generated sealed envelopes. The control group received no treatment, the acupoint group received TENS bilaterally at the PC-5 and PC-6 points (on the palmar side of both arms, between the tendon of the long palmar muscle and radial flexor muscle of the wrist)[14] (Fig. 1) using a TENS stimulator (NeuroTrax™ TENS & AcuStim; Verity Medical Ltd, Hampshire, UK), and the non-acupoint group received TENS at non-acupoints of both shoulders[8] (Fig. 1) using the TENS stimulator. All parturients fasted for a minimum of 6 h before operation. On arrival in the operation room, all parturients had standard monitoring in place (non-invasive blood pressure, ECG, and pulse oximetry) and 5 min later, the baseline values were recorded in the supine position. In the acupoint and non-acupoint groups, small-sized (1.5 cm) cutaneous electrode pads were placed bilaterally at the PC-6 and PC-5 points and non-acupoints of the shoulders, respectively. The intensity of the electrical stimulation was adjusted to produce the most intense tolerable electrical sensation without muscle contractions or uncomfortable feelings at a frequency of 50 Hz. The electrical stimulation was administered until delivery. Large-bore i.v. access was secured and acetated Ringer's solution (10 ml kg^{-1}) was administered before the induction of anaesthesia. With the parturients in the right lateral position, a 20-gauge epidural catheter was placed after identification of the epidural space at the L1–L2 interspace using a 17-gauge Tuohy needle. Then, dural puncture was performed at the L3–L4 interspace using a median approach and a 25-gauge Quincke needle. After free flow of cerebrospinal fluid had been obtained, 2.4 ml of isobaric bupivacaine 0.5% and 0.4 ml of fentanyl (20 μg) was injected intrathecally over approximately 15 s. Then, the parturients were positioned supine. Oxygen at 2–3 litre min^{-1} was delivered via a face mask.

The sensory block level was assessed by pinprick at the left mid-clavicular line every 2 min. Surgery was allowed to start when at least the T6 dermatome was blocked. The extent of sensory block obtained at incision was considered to be the maximal blocked level, as further follow-up might be inappropriate once surgery started. In the case of insufficient cephalad spread of anaesthesia, incremental epidural supplements of lidocaine 1% were injected, starting with 5 ml. When necessary, additional 3 ml boluses were given no earlier than 5 min after the preceding top-up. Haemodynamics were recorded every minute until delivery. Ephedrine i.v. in increments of 4 mg was given every 2 min to treat hypotension, defined in the present study as a decrease in systolic blood pressure (SBP) 30% below baseline values or to <90 mm Hg. SBP, diastolic blood pressure (DBP), and heart rate (HR) were recorded every minute until delivery. The parturient and provider were not blinded; however, the individual collecting data were blinded to group allocation.

A pilot study using 15 patients showed the mean (SD) of the lowest SBP to be 74 (9), 99 (13), and 83 (8) in the control, acupoint, and non-acupoint groups, respectively. Thus, a group size of at least 10 patients was needed to show a difference of 15 (SD 10) mm Hg in the lowest SBP with a significant level of 0.05 (α=0.05) and a power of 80% (β=0.20). Data are expressed as median (range). Statistical analysis was performed using the Kruskal–Wallis test followed by Student–Newman–Keuls method for multiple comparisons. $P<0.05$ was considered to be significant.

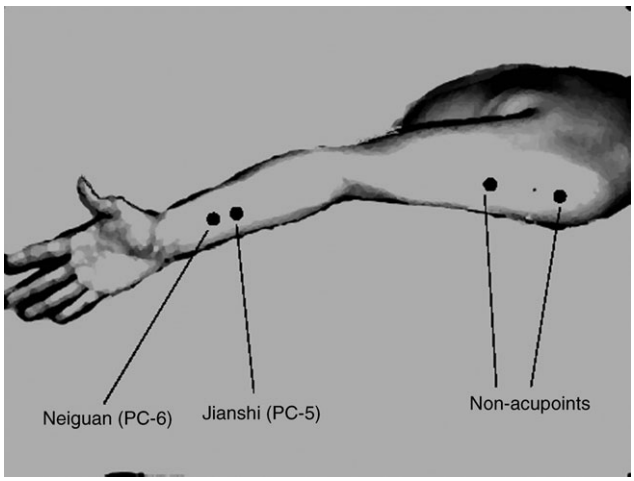

Fig 1 The locations of small-sized cutaneous electrode pads for TENS.

Results

Patient characteristics, baseline measurements to delivery interval, and maximal block height were comparable among the three groups (Table 1). Baseline SBP, DBP, and HR were similar among these groups (Table 2). The intensity of TENS was the same between the acupoint and the non-acupoint groups. The number and amount of epidural supplementation were similar among the three groups.

The lowest recorded SBP and DBP were significantly higher in the acupoint group compared with the other groups and the SBP of the non-acupoint group was higher than that of the control group (Table 2). Significantly more parturients in the control and non-acupoint groups experienced hypotension. The HR after spinal anaesthesia was not different among these groups. More ephedrine was

Table 1 Patient characteristics and anaesthetic data of parturients undergoing Caesarean section. Data are mean (range), mean (SD) or number (percentage). Base–del interval, baseline measurements to delivery interval

	Control ($n=12$)	Acupoint ($n=12$)	Non-acupoint ($n=12$)	*P*-value
Age (yr)	33 (31–35)	31 (29–35)	29 (26–32)	0.114
Height (cm)	158 (5)	161 (3)	158 (7)	0.441
Weight (kg)	61 (6)	59 (6)	64 (9)	0.448
Maximal block height (dermatome)	T5 (T3–T6)	T5 (T4–T6)	T5 (T4–T6)	0.763
Epidural supplementation (*n*)	3 (25%)	3 (25%)	3 (25%)	1.00
Amount of epidural lidocaine 1% (ml)	0 (0–2.5)	0 (0–2.5)	0 (0–2.5)	1.00
Base–del interval (min)	43 (35–49)	39 (37–50)	40 (30–50)	0.893

Table 2 Haemodynamic variables of parturients undergoing Caesarean section. Data are median (range) or number (percentage). SBP, systolic blood pressure; DBP, diastolic blood pressure. *Using Mann–Whitney test. †Significantly different from the other groups. ¶Significantly different from the control group

	Control ($n=12$)	Acupoint ($n=12$)	Non-acupoint ($n=12$)	*P*-value
Intensity of TENS (mA)	—	12 (9–15)	13 (9–18)	0.237*
Baseline SBP (mm Hg)	119 (115–127)	126 (113–135)	118 (110–123)	0.355
Lowest SBP (mm Hg)	70 (68–82)	94 (84–109)†	81 (70–92)¶	<0.001
Baseline DBP (mm Hg)	60 (50–76)	66 (58–88)	62 (46–86)	0.069
Lowest DBP (mm Hg)	27 (20–50)	44 (30–68)†	36 (26–44)	<0.001
Baseline HR (beats min^{-1})	76 (65–92)	82 (64–120)	83 (70–105)	0.154
HR at lowest SBP (beats min^{-1})	68 (48–110)	81 (64–110)	84 (60–120)	<0.05
Incidence of hypotension (*n*)	10 (83%)	4 (33%)†	10 (83%)	0.013
Ephedrine (mg)	8 (8–16)	0 (0–12)†	14 (8–18)	0.025

required to maintain arterial blood pressure in the control and non-acupoint groups compared with the acupoint group (Table 2).

Discussion

The present study showed that TENS itself reduced the severity of hypotension of parturients after spinal anaesthesia, and that TENS at specific acupoints further reduced the severity and incidence of hypotension.

Electroacupuncture at an acupuncture point is known to influence haemodynamics and cardiovascular sympathoexcitatory responses.[14–16] Electroacupuncture at the PC-6 point is known to increase stroke volume and cardiac output, and alleviate haemorrhagic hypotension.[12 13] In the present study, TENS was delivered at the most intense tolerable electrical sensation, and it would not be surprising if TENS itself had some sympathomimetic effect,[17] as shown in the non-acupoint group. When giving the same level of electrical stimulation, however, TENS at the specific acupoints significantly reduced the severity of hypotension compared with TENS at the non-specific points. An electrical stimulation of somatic afferents from muscle at 40 Hz causes a pressor response.[18] Electroacupuncture at the PC-6 point also augments sympathetic tone and improves the inhibited cardiovascular function.[12 13] We thus postulate that TENS applied on the PC-6 and PC-5 points might have augmented sympathetic tone, thereby increasing cardiac function and vascular tone and alleviating hypotension after spinal anaesthesia in parturients undergoing Caesarean section.

A limitation in the present study is the failure to clarify the optimal frequency of electrical stimulation of TENS. In fact, some studies showed that electoacupuncture at 2–4 Hz can inhibit cardiovascular sympathoexcitatory responses.[10 11] In contrast, electroacupuncture stimulation frequency to 5 Hz did not lead to any effect on the cardiovascular system and increasing the frequency to 30–70 Hz induced recognizable pressor responses.[12 13] Thus, we chose the frequency of 50 Hz in the present study. However, we need further studies in order to find the optimal frequency of TENS. Another limitation is that the incidence of epidural supplementation was relatively high in each group in the present study (25%). We speculated that the spinal dose of bupivacaine would have been insufficient for the spinal anaesthesia of Caesarean section in the present study. We also consider that the use of isobaric bupivacaine might have led to the present results and that repeating spinal anaesthesia with hyperbaric bupivacaine would decrease the need for epidural supplementation and alter the results.

In conclusion, TENS on the traditional acupuncture points reduced the severity and incidence of hypotension after spinal anaesthesia in parturients.

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