

Peripheral nerve stimulator-induced electrostimulation at the P6 point reduces the incidence of post-spinal hypotension in patients undergoing post-trauma orthopaedic surgery

Al Rawahi KS, MD, Resident; Khan RM, MD, Senior Consultant; Kaul N, MD, Senior Consultant and Head
Department of Anaesthesia and Intensive Care Unit, National Trauma Centre, Khoula Hospital, Muscat, Sultanate of Oman

Azharuddin M, MD, Assistant Professor

Department of Medicine, Jawaharlal Nehru Medical College, Aligarh, India

Correspondence to: Naresh Kaul, e-mail: seeras_alig@rediffmail.com

Keywords: P6 electroacupuncture, spinal anaesthesia, hypotension

Abstract

Objectives: Sympathetic block following spinal anaesthesia is often associated with a fall in blood pressure. This fall has been shown to be attenuated by using transcutaneous nerve stimulation at the P6 point in patients receiving spinal anaesthesia for Caesarean section. The aim of this study was to evaluate the efficacy of stimulation at the P6 point, using peripheral nerve stimulator (PNS), for the prevention of a fall in blood pressure in trauma patients undergoing surgery under spinal anaesthesia.

Design: Randomised, open-label, parallel-assignment, interventional trial.

Setting and subjects: Thirty-two American Society of Anesthesiologists I and II young adult patients of either sex, who were scheduled for elective post-trauma lower limb orthopaedic surgery under spinal anaesthesia, were randomised into two equal groups. The control group (group A) received no P6 stimulation, while the study group (group B) received train-of-four electrical stimulation using the peripheral nerve stimulator (PNS) immediately prior to spinal anaesthesia until the completion of surgery.

Outcome measures: The primary outcome measure was mean arterial pressure (MAP) and the secondary outcome measure was heart rate and use of vasopressors.

Results: Of the 32 patients, there was a fall in mean arterial pressure (MAP) from basal value following spinal anaesthesia in 16 patients receiving P6 stimulation (group B), as well as in those not receiving it (group A). However, the onset of significant fall in MAP was not only delayed (20 minutes vs. 10 minutes), but was also of shorter duration (10 minutes vs. 50 minutes), in group B patients, than it was in patients in the non-stimulated group (group A), respectively.

Conclusion: Electrostimulation by PNS of the P6 point successfully attenuates the severity and duration of hypotension after spinal anaesthesia during post-trauma orthopaedic surgery.

© Peer reviewed. (Submitted: 2012-12-03. Accepted: 2013-04-05.) © SASA

South Afr J Anaesth Analg 2013;19(4):216-218

Introduction

Spinal anaesthesia is often associated with hypotension and bradycardia.¹ Strategies to manage post-spinal hypotension include the use of vasopressors or fluids, or a judicious combination of both. This treatment modality for post-spinal hypotension has disadvantages, such as tachycardia, and rarely, fluid overload. Recently, Arai et al² demonstrated the efficacy of transcutaneous electrical nerve stimulation (TENS) at the P6 and P5 acupuncture points to attenuate post-spinal hypotension in patients undergoing Caesarean section. The P6 point is known to influence the vascular and cardiovascular sympathetic system. Unfortunately, TENS

machines are rarely available in operation theatres, whereas peripheral nerve stimulators (PNSs) are readily so. Since PNSs have been successfully used in the past to stimulate the P6 point to control postoperative nausea and vomiting in place of TENS,³ we hypothesised that in this pilot study, PNS could also be used in place of TENS to stimulate the P6 point and to successfully attenuate post-spinal hypotension in patients undergoing orthopaedic surgery.

Method

After approval by the hospital ethical committee, 32 American Society of Anesthesiologists I and II young adult,

non-obese male patients, scheduled for elective post-trauma orthopaedic surgery of the lower limb under spinal anaesthesia, were selected for this pilot study. Patients with a history of diabetes mellitus, coronary artery disease or hypertension were not included in the study. The procedure was explained and written informed consent obtained from patients who were randomly divided into two groups of 16, each using the chit-in-a-box technique. Using this randomisation technique, 32 folded chits for each of the two groups were kept mixed in a box. Whenever a patient presented who fulfilled the selection criteria as laid down in the study, a chit was withdrawn from the box and opened by a researcher immediately prior to surgery and anaesthesia. Spinal anaesthesia, with or without electrical stimulation at the P6 point, was administered to the patient as per this chit allotment. The group A (control) patients did not receive electrical stimulation, while the group B (study) patients were administered 10 mA current stimulation at the P6 point on the dominant hand using the train-of-four mode of the PNS (Innervator Constant Current Peripheral Nerve Stimulator®, Fisher & Paykel Healthcare System, New Zealand).

Patients were premedicated with oral midazolam 7.5 mg, 45-60 minutes prior to administration of spinal anaesthesia. All patients received a preload of 10 ml/kg of Ringer's lactate solution prior to initiation of spinal anaesthesia. A small-sized (2 cm) EKG cutaneous electrode was placed at the P6 (neiguan) point of the dominant hand in group B patients. This point is situated between the tendons of the palmaris longus and the flexor carpi radialis, two Chinese inches from the distal skin crease of the wrist. One Chinese inch equals the width of the interphalangeal joint of the thumb.⁴ A second electrode was placed one inch proximal to this point. After reinforming the patient about the procedure, the two leads of the PNS were attached (the cathode to the P6 point and the anode to the second electrode), and train-of-four stimulation started at 10 mA, current intensity 12 seconds repeat mode, i.e. 4 stimulus at a frequency of 1-2 Hz every 12 seconds. This was initiated immediately before administration of spinal anaesthesia, and lasted until conclusion of the surgery. Spinal anaesthesia was administered in the sitting position using a 25G Quincke's needle in both the groups, using 2.5 ml of 0.5% heavy

bupivacaine, plus 15 µg of preservative-free fentanyl. The height of the sensory block was assessed by a pinprick in the midclavicular line. Surgery under tourniquet was allowed to commence after the sensory block reached at least the T8 dermatomal level.

Recording of parameters

Mean arterial pressure (MAP) was recorded before administering spinal anaesthesia (Basal value), and thereafter every five minutes for the first half an hour, and then at one and two hours. If MAP was < 30% of the basal value, ephedrine 6 mg bolus was to be administered every 3-5 minutes to treat hypotension. If the heart rate (HR) was less than 50/minute, atropine 0.3 mg was to be administered every 3-5 minutes to treat bradycardia.

The total number of patients needing ephedrine and atropine, as well as the total administered dose, were recorded.

Statistical analysis

Data in the tables were presented as mean ± standard deviation. Data were analysed, using SPSS® version 17. The independent samples t-test was employed to compare the MAP and HR data between the groups, while the chi-square test was used for qualitative variables, i.e. the frequency of the inotrope used. P-value < 0.05 was considered to be significant in this study.

Results

The mean ages of the patients in groups A and B were 30.3 ± 9.7 years and 28.9 ± 9.7 years, respectively.

Table I shows that there was a fall in MAP from the basal value following spinal anaesthesia in both the groups. When this fall was compared between the groups, no statistical difference was noted between the two groups. This could be attributed to the more common use of ephedrine in the control group. However, the onset of a fall in MAP was not only delayed (20 minutes vs. 10 minutes), but was also of a shorter duration (10 minutes vs. 50 minutes), in group B patients, than in the non-stimulated group (group A) patients, respectively.

Table I: Variations in mean arterial pressure (mmHg) in the two groups during the study period

Group	0 minutes	5 minutes	10 minutes	15 minutes	20 minutes	30 minutes	1 hour	2 hours
Group A (control)	91.4 ± 13.2	83.7 ± 12.2	75.9 ± 14.5	77.5 ± 16.9	79.4 ± 14.9	80.9 ± 14.1	81.5 ± 13.8	83.6 ± 13.7
Group B (study)	89.4 ± 13.0	83.8 ± 17.1	81.9 ± 16.2	81.1 ± 12.7	79.1 ± 9.4	78.3 ± 12.4	80.8 ± 10.9	81.2 ± 10.3

0 minutes (basal value): just before administration of spinal anaesthesia
5, 10, 15, 20 and 30 minutes, and 1 and 2 hours: after administration of spinal anaesthesia

Table II: Variations in the heart rate/minute during the study period in the two groups

Group	0 minutes	5 minutes	10 minutes	15 minutes	20 minutes	30 minutes	1 hour	2 hours
Group A (control)	84.9 ± 20.4	81.0 ± 18.1	78.7 ± 18.4	73.3 ± 13.8	69.9 ± 15.4	69.8 ± 15.1	69.6 ± 13.1	73.2 ± 10.4
Group B (study)	77.9 ± 13.9	76.2 ± 15.1	76.1 ± 13.6	73.1 ± 11.5	73.1 ± 8.8	72.5 ± 6.9	69.3 ± 8.1	70.9 ± 6.4

0 minutes (basal value): just before administration of spinal anaesthesia
5, 10, 15, 20 and 30 minutes, and 1 and 2 hours: after administration of spinal anaesthesia

Table III: The maximum fall in mean arterial pressure and heart rate from the basal value and the need for ephedrine or atropine in the two groups during the study period

Group	Mean fall in MAP from basal value (mmHg)	Mean fall in HR from basal value (HR/minute)	Number of patients needing ephedrine, %	Number of patients needing atropine, %
Group A (control)	16	15	6, 35.3	3, 17.6
Group B (study)	10	7	2, 11.8	1, 5.9

*: p-value < 0.05, when compared with group B
HR: heart rate, MAP: mean arterial pressure

A fall in the HR from basal value was noted following spinal anaesthesia in both groups (Table II). However, there was no significant difference in the slowing of HR between the two groups (p-value > 0.05). This could be attributed to the more common use of ephedrine and atropine in the control group, compared to that in the study group.

As is evident from Table III, the maximum fall in MAP and HR during the study period was lower in the study group (group B), compared to that in the control group (group A), although it did not reach a level of statistical significance. The number of patients who needed ephedrine or atropine to control hypotension or bradycardia, respectively, was reduced by 66% in the stimulated group (group B), than it was in the control group. This difference was statistically significant (p-value < 0.05).

Discussion

Sympathetic blockade following spinal anaesthesia often leads to undesirable hypotension. The present study substantiates the findings of Arai et al² that electroacupuncture at the P6 point reduces the severity and incidence of hypotension after spinal anaesthesia, and also necessitates less administration of ephedrine. In our study, this fall was not only delayed in onset, but was also for a reduced time. The statistically insignificant difference in the haemodynamic parameters between the groups may be attributed to the underpowered study because of the small sample size, and also because haemodynamic parameters were altered by adjuvant inotropic and chronotropic use. The significantly less frequent requirement of inotrope in the study group is a positive outcome in favour of the use of P6 electrostimulation.

We chose the train-of-four mode of stimulation at 10 mA as this was most acceptable to our patients without them being uncomfortable. The results of this study suggest that PNS is a suitable alternative to the TENS machine for the administration of electrostimulation at the P6 point to alleviate post-spinal hypotension.

A second point of interest that was observed in this study was the lesser incidence of slower HR during the study period in the P6-stimulated group.

It may be argued that apprehension, in response to electrostimulation anywhere in the body, was responsible for endogenous catecholamine liberation, thereby augmenting the sympathetic tone. However, in their study,

Arai et al² successfully demonstrated that it was only electrostimulation of the traditional acupoint (P6) which significantly reduced the severity of hypotension, compared with TENS at the non-specific points.

The exact mechanism is not known, but it is speculated that electrostimulation at the P6 point may elicit cardiovascular sympathoexcitatory responses,^{2, 5-7} leading to augmentation of sympathetic tone and an increase in stroke volume.^{8,9}

A limitation of this study was that it did not include a non-P6 point stimulation group, nor did it compare the results with the use of TENS. The former was because this point had already been covered by the work by Arai et al,² and the latter was because we did not have a TENS machine in our operation theatre.

In conclusion, electrostimulation by PNS of the P6 point successfully attenuates the severity and duration of hypotension after spinal anaesthesia during post-trauma orthopaedic surgery.

Conflict of interest

The authors have no conflict of interest to declare.

References

- Morgan Jr GE, Mikhail MS, Murray JM. Clinical anesthesiology. 4th ed. New York: Lange Anesthesiology; 2006.
- Arai YCP, Kato N, Matsura M, et al. 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. *Br J Anaesth.* 2008;100(1):78-81.
- Khan RM, Maroof M, Hakim S, et al. Intraoperative stimulation of the P6 point controls postoperative nausea and vomiting following laparoscopic surgery. *Can J Anesth.* 2004;51(7):740-741.
- Rowbotham DJ. Nausea, vomiting and their treatment. 4th ed. In: Aitkenhead AR, Rowbotham DJ, Smith G, editors. *Textbook of anaesthesia.* Edinburgh: Churchill Livingstone; 2001.
- Li P, Ayannusi O, Reid C, Longhurst JC. Inhibitory effect of electroacupuncture (EA) on the pressor response induced by exercise stress. *Clin Auton Res.* 2004;14(3):182-188.
- Haker E, Egekvist H, Bjerring P. Effect of sensory stimulation (acupuncture) on sympathetic and parasympathetic activities in healthy subjects. *J Auton Nerv Syst.* 2000;79(1):52-59.
- Li Z, Wang C, Mak AF, Chow DH. Effects of acupuncture on heart rate variability in normal subjects under fatigue and non-fatigue state. *Eur J Appl Physiol.* 2005;94(5-6):633-640.
- Syuu Y, Matsubara H, Kiyooka T, et al. Cardiovascular beneficial effects of electroacupuncture at Neiguan (PC-6) acupoint in anesthetized open-chest dog. *Jpn J Physiol.* 2005;51(2) 231-238.
- Syuu Y, Matsubara H, Hosogi S, Suga H. Pressor effect of electroacupuncture on hemorrhagic hypotension. *Am J Physiol Regul Integr Comp Physiol.* 2003;285(6):R1446-R14452.