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Prophylactic Infusions of Phenylephrine and Ephedrine during Combined Spinal Epidural Anaesthesia for Caesarean Section: A Comparative Study

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Abstract

Background: Hypotension is the most common adverse effect in parturients after spinal anaesthesia for Caesarean section. Despite various pharmacological and non-pharmacological methods used in its prevention and treatment, vasopressors have become very important in the management of this form of hypotension.

Objective: This study was aimed at comparing the efficacy and safety of prophylactic intravenous infusions of phenylephrine and ephedrine at preventing maternal hypotension during Combined Spinal Epidural anaesthesia (CSE) for Caesarean section.

Methods: Sixty ASA I and II patients scheduled for elective Caesarean section, were randomly allocated into two groups. Patients in Group I received Phenylephrine 80 µg/min while patients in Group II received Ephedrine 1 mg/min immediately after the subarachnoid 10 mg plain bupivacaine injection while the epidural catheter was being inserted and secured. All the patients received a crystalloid preload of 1 litre of 0.9% normal saline prior to the induction of CSE.

Results: The overall incidence of hypotension was 8.5% (6.7% in the phenylephrine group and 10.3% in the ephedrine groups). The lowest systolic (105.8 ± 9.2 mmHg) and diastolic arterial pressures (60.9 ± 8.9 mmHg) occurred in the ephedrine group while the lowest heart rates occurred in the phenylephrine group. The mean umbilical artery pH was 7.3 while Apgar scores at 1st and 5th min were essentially the same in the two groups.

Conclusion: Prophylactic intravenous infusions of phenylephrine and ephedrine are safe and effective at reducing the incidence and severity of hypotension during combined spinal epidural anaesthesia for elective Caesarean section with no associated neonatal acidosis.

Keywords: Combined spinal epidural anaesthesia; Caesarean section; Prophylactic intravenous infusions; Phenylephrine; Ephedrine

Introduction

Caesarean section is now frequently performed under regional anaesthesia world-wide following the advantages of this technique over general anaesthesia. Some of the advantages of regional over general anaesthesia will include less maternal risks of gastric content aspiration, airway management difficulties, shorter recovery time, and faster attainment of cognitive functions. Regional anaesthesia for Caesarean section is associated with hypotension which predisposes the newborn to acidosis. The acidosis is related to the treatment of hypotension with vasopressors. Ephedrine was the vasopressor of choice in obstetrics but there is an increasing evidence that it has the propensity to reduce foetal pH and base excess, especially in comparison with other vasopressors such as phenylephrine [1,2] and metaraminol [3]. Severe maternal hypotension gives rise to a reduction in utero-placental perfusion leading to foetalbradycardia and acid-base abnormalities and if prolonged, may lead to neuro-behavioural changes in the newborn [4]. It should therefore be prevented and/or treated promptly.

Although the haemodynamic responses to vasopressors used during regional anesthesia for Caesarean delivery have not been well described, ephedrine use has been found to be associated with the potential to cause supra-ventricular tachycardia, tachyphylaxis, and foetal acidosis [5]. Consequently, recent studies favour the use of α-agonists such as phenylephrine [6,7]. Phenylephrine is a α-1 agonist which elevates arterial blood pressure by increasing systemic vascular resistance secondary to vasoconstriction. It has a less depressive effect on foetal pH and base excess. Current evidence suggests that infusions of vasopressors are best titrated to maintain blood pressure to near baseline levels [6].

Therefore, this randomized, double-blind study was designed to demonstrate the effects of ephedrine and phenylephrine prophylaxis in the prevention of hypotension during Combined Spinal Epidural Anaesthesia (CSE) for elective Cesarean delivery.

Methods

The study was approved by the University of Port Harcourt Teaching Hospital's Clinical Research Ethics Committee. All patients gave informed consent. Sixty ASA I and II parturients scheduled for elective Caesarean section under CSE were randomly allocated into two vasopressor infusion groups of 30 patients each using sealed envelopes. The operation suite nurse, not involved in the study opened the already coded and sealed envelope for the parturients to pick from. The study solutions were prepared by an anesthesiologist not involved in the study.

Patients in Group 1 received 80 µg of phenylephrine/minute while patients in Group 2 received 1 mg of ephedrine/minute. Both infusions were commenced immediately using a Graseby® syringe

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pump following the subarachnoid block while the epidural catheter was being inserted and secured. The vasopressors were delivered in syringes containing 50ml of the study drug (prepared by an anaesthetist not involved in the collection of data and/or analysis of the results).

Inclusion criteria included, all uncomplicated, singleton term pregnancy scheduled for elective Caesarean section. Excluded from the study were refusal to participate in the study, patients younger than 18 years of age, bleeding disorder, pre-eclampsia, gestational age <36 weeks and those with intercurrent medical diseases. Patients with a history of allergy to the study drugs, anatomical deformity of the vertebrae, severe maternal hypovolaemia, coagulation disorders, localized infection over the injection site, neurological disorders, severe congenital or acquired heart disease and a conversion to general anaesthesia.

On the morning of surgery, the parturients were transferred into the operating room in the lateralposition. Monitors were attached and baseline vital signs (electrocardiogram, non-invasive blood pressure, pulse rate, peripheral oxygen saturation and temperature) measured and recorded using an automated, non-invasive device (Ajour Huntleigh® multiparameter monitor). Intraoperative fluid requirement was administered according to the patient's need by the attending anaesthetist. Two 16-Gauge intravenous cannulas were inserted into two separate forearm veins. One was used to infuse a fluid preload of 10 ml/kg of 0.9% normal saline over 15 minutes before the block, while the second was used to run the respective vasopressor infusion.

Patients were positioned by a trained assistant in the sitting position for the CSE. The epidural space was identified with an 18-gauge Tuohy needle using the Loss-of-Resistance to Saline (LOR-S) technique. A 27-gauge Whitacre needle was then advanced through the Tuohy needle to locate the subarachnoid space indicated by free flow of Cerebrospinal Fluid (CSF). Isobaric 0.5% bupivacaine 10mg was then administered intrathecally. The infusion containing the respective vasopressor was then opened by the assistant at the rates stated above. Patients remained in the sitting position for a maximum of 3 minutes while a 20-G epidural catheter (Sims Portex Limited, Hythe, Kent, United Kingdom) was being inserted, leaving 3-4 cm in the epidural space.

After an aspiration test, the epidural catheter was attached to a bacterial filter (Sims Portex Limited), which had been primed with saline. Following the placement of a sterile dressing over the skin puncture site, tape was applied to secure the epidural catheter and the patient returned to the supine position, with a 20 degree left lateral uterine displacement and a pillow placed under the patient's shoulder and head. Patients with technical problems with epidural catheter insertion exceeding 3 minutes were excluded from the study.

Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP) and Heart Rate (HR) were measured and recorded every minute following the intrathecal injection until delivery of baby and every 5 minutes until patients were discharged from the recovery room. For the purpose of this study, maternal hypotension was defined as SBP equal to or lower than 80% of baseline values and was treated with a bolus of 50% of initial dose of vasopressor and a rapid intravenous fluid bolus (250-500 ml of 0.9% normal saline) and 50% bolus of the initial dose of the respective vasopressor (rescue vasopressor) until SBP was 80% of baseline values or higher. Reactive hypertension was defined as blood pressure 20% higher than baseline values after the use of the vasopressor infusion and was managed by discontinuing the vasopressor infusion. Heart rate lower than 60 beats per minute indicated bradycardia if accompanied by hypotension; and was treated with intravenous atropine 0.6 mg.

Assessment of block before surgery was done using loss of cold sensation to cotton wool soaked in ethyl alcohol and the modified Bromage score. Loss of cold sensation up to the 6th thoracic dermatomal level (T6) and a Bromage score of 2 or 3 were considered adequate for surgery. If the upper level failed to reach T6 after 10 mins, 2% plain lidocaine was given in incremental doses of 2 ml per unblocked segment through the epidural catheter. If it became necessary to convert to general anaesthesia, the patient was excluded from the study.

Oxytocin 5 IU was given intravenous at the delivery of the anterior shoulder of the baby followed by 10 IU in 500 ml 0.9% normal saline by slow infusion. Apgar scores at 1 and 5 minutes and umbilical artery pH using a pH meter (IQ Scientific Instruments, Minilab Model IQ 125 USA) were used to determine neonatal outcomes.

For breakthrough pain intra-operatively, incremental epidural top-up with 4 ml 2% plain lidocaine was given. Additional 2 ml boluses were given not earlier than 5 mins after the preceding to-up. Additional data included time from spinal injection to supine position, skin incision to delivery of the foetus (incision-delivery interval), lowest blood pressure and the total dose of vasopressor used.

All patients were given 8 ml of 0.25% plain bupivacaine within 30 mins after surgery for post-operative analgesia through the epidural catheter. This dose was repeated as needed for post-operative pain control for the first 24 hours and then removed (catheter tip shown to the patient before and after insertion) to allow for early ambulation. Patients were followed up for 72 hours post-operatively for complications which were managed appropriately as they occurred.

The primary outcome was difference in mean lowest systolic blood pressure. Using data from one study, we calculated that a sample size of 60 patients per group would have a 90% power at the 5% significance level to detect a 10 mmHg difference with a standard deviation of 5 mmHg, in the mean lowest systolic blood pressure among groups. Secondary outcomes were incidence of hypotension, mean lowest heart rate, upper sensory level, and neonatal outcome. All data collected were fed into a spread sheet and analysed using the Statistical Package for Social Sciences (SPSS) 15.0 software (SPSS, Chicago, IL, USA) for windows and Winpepi (Copyright Abramson JH, June 14 2009. version 9.7, School of public health and community medicine, Hebrew university, Jerusalem).Results were presented in tables and expressed as means and standard deviations and number of patients/percentage. Statistical association was determined using the chi-square test for categorical variables and t-test for continuous variables. A p-value of less than 0.05 was considered statistically significant.

Results

Fifty nine (98.33%) patients participated throughout the study while one patient (1.67%) was excluded following conversion to general anaesthesia. Maternal demographic data were similar in the two groups (Table 1). Table 2 shows the indications for Caesarean section in the two groups. Fifty six percent of patients in this study had had previous Caesarean sections, while the other indications constituted the remaining 44%. Table 3 shows the peri-operative intervals in both groups. These intervals were essentially the same in the two groups.

Table 4 shows the blood pressure and heart rate trends from the time of the spinal injection to delivery of the foetus in groups 1 and 2 respectively. The baseline haemodynamic values (time 0) were similar in both groups. The mean baseline SystolicArterial Blood Pressure(SBP) was 132.9 ± 7.4 mmHg in group 1 and 132.0 ± 9.1 mmHg in group 2, p=0.691 while the mean baseline Diastolic Arterial Blood Pressure (DBP) was 82.2 ± 8.5 mmHg in group 1 and 80.7 ± 7.8 mmHg in group

Variable	Group-I	Group-II	t-value	p (2-tailed)
Age (years)	32.6 ± 4.7	32.6 ± 4.7	0.55	0.587
Weight (kg)	88.2 ± 11.0	84.0 ± 11.6	1.41	0.163
Height (m)	1.63 ± 0.51	1.62 ± 0.44	0.61	0.543
Gestational age (weeks)	38.5 ± 1.3	38.9 ± 1.5	0.65	0.513
† Parity	2 [0-3]	2 [0-3]		
Estimated blood loss (ml)	517.5 ± 220.3	560.4 ±190.2	0.80	0.428
Total dose of vasopressor used (mg)	0.426 ± 0.123.6	4.96 ± 1.1		
†Block height before skin incision	T5 [T4-T6]	T5 [T4-T6]		
† Number of doses of post-op				
epidural bupivacaine	3	3		

(Mean ± SD)
†The Parity, block height (upper sensory level) and number of doses of post-operative epidural bupivacaine are expressed here as median

Table 1: Patients' Characteristics.

Indications	Group-I n=30	Group-II n=29	P value
Previous C/S	18 (60)	15 (51.7)	0.21
Post-date Pregnancy and previous C/S	3 (10)	6 (20.7)	0.48
Primigravida breech at term	3 (10)	4 (13.8)	0.32
Previous myomectomy, high maternal age	2 (6.7)	1 (3.4)	0.30
PMTCT	3 (10)	1 (3.4)	0.08
Transverse lie at term	1 (3.3)	2 (3.4)	0.30

Number (percentage)

Table 2: Indications for Caesarean section.

Intervals (minutes)	Group-A n=30	Group-B n= 29	t-value	p-value
Spinal injection to supineposition	3.2 ± 0.6	3.3 ± 0.7	4.14	0.470
Spinal injection to skin incision	6.7 ± 1.3	6.5 ±1.3	0.64	0.526
Spinal injection to delivery	11.1 ± 2.1	10.8 ± 3.0	0.40	0.68
Incision - delivery	4.8 ± 1.8	4.7 ± 2.2	0.15	0.884
Supine position to delivery	8.0 ± 1.8	7.8 ± 2.8	0.34	0.736
Duration of surgery	43.2 ± 14.6	42.6 ± 13.2	0.17	0.810

(Mean ± SD)

Table 3: Peri-operative intervals.

2, p=0.502. The mean baseline Heart Rate (HR) were 87.5 ± 17.4 beats/min and 90.4 ± 10.3 beats/min in group I and II respectively, p=0.440. These differences in the values were not statistically significant. The lowest SBP (105.8 ± 9.2 mmHg) and DBP (60.9 ± 8.9 mmHg), occurred in group 2 while the trend of the heart rate was generally lower in Group 1 than in Group 2.

Table 5 shows the neonatal outcomes in both groups. There was no statistical difference in the umbilical artery pH (p=0.490) and the Apgar scores at 1 min (p=0.626) and 5 min (p=0.707).The mean umbilical artery pH was 7.3 ± 0.6 in group 1 and 7.3 ± 0.4 in group 2.

Table 6 shows the incidence of complications in the two groups. More complications occurred in the phenylephrine group than in the ephedrine group, the commonest complication in the two groups being shivering. The overall incidence of hypotension in this study was 8.5%. Two (6.7%) and three (10.3%) parturients in groups 1 and 2 respectively developed hypotension. It was treated with rapid intravenous fluid (250-500 ml of 0.9% normal saline) and 50% bolus of the initial dose of the respective vasopressor (rescue vasopressor) until SAP was 80% of baseline values or higher.

Post spinal shivering occurred in 3 (10.0%) patients in group 1 and 5 (17.2%) of 29, patients in group 2. Nausea and vomiting occurred in 1 (3.3%) patient in group 1 and none in group 2. The patient who vomited had extensive adhesiolysis. The episode of nausea or vomiting was transient and did not receive any treatment.

Figures 1 and 2 shows a line chart demonstrating the systolic and diastolic blood pressure patterns in the two vasopressor groups from the time of the spinal injection to just after the delivery of the foetus. The graph indicates a slightly better control of SBP in the phenylephrine (group 1) than in the ephedrine (group 2) from the third minute. Figure 1 also shows that the DBP was slightly higher in the phenylephrine group than in the ephedrine group.

Figure 3 is a line chart showing the HR trend in the two vasopressor

Time (mins)	Systolic Blood Pressure†		Diastolic Blood Pressure†		Heart Rate*	
	Group 1 n=30	Group 2 n=29	Group 1 n=30	Group 2 n=29	Group 1 n=30	Group 2 n=29
1	132.9	132.0	82.2	80.7	87.5	90.4
2	132.0	132.0	82.2	80.7	87.5	90.4
3	135.0	134.0	80.5	82.4	88.9	90.0
4	135.0	132.0	50.5	82.4	84.8	88.9
5	131.6	134.0	70.8	67.8	80.8	90.0
6	125.6	128.3	71.5	68.8	77.8	89.6
7	120.3	117.4	78.5	72.4	78.4	87.8
8	115.7	110.4	78.5	72.4	75.6	84.7
9	107.9	105.8	62.6	60.9	72.9	86.1
10	107.9	105.8	62.6	60.9	72.9	86.1
11	115.7	110.4	65.5	64.4	75.6	84.7
12	118.8	118.0	70.0	69.7	83.4	88.5

†Blood pressure is expressed as mmHg. *Heart rate expressed as beats per minute

Table 4: Showing systolic, diastolic blood pressure and heart rate patterns in the two groups.

Variable	Group-I n=30	Group-II n= 29	t-value	p (2-tailed)
Birth weight (kg)	3.5 ± 0.4	3.5 ± 0.3	0.31	0.761
Apgarscore				
At 1 min	8.4 ± 0.6	8.5 ± 0.7	0.49	0.626
At 5 min	9.8 ± 0.4	9.8 ± 0.4	0.38	0.707
Umbilical artery pH	7.3 ± 0.6	7.3 ± 0.4	0.70	0.490

(Mean ± SD)

Table 5: Neonatal outcomes.

Complications	Group-I (n=30) (%)	Group-B (n= 29) (%)	p value
Hypotension	2 (6.7)	3 (10.3)	0.27
Nausea	1 (3.3)	0	0.42
Vomiting	1 (3.3)	0	0.42
Shivering	3 (10)	5 (17.2)	0.16
Tachycardia	3 (10)	0	0.07
Reactive hypertension	3 (10)	1 (3.4)	0.09
Epidural top up for analgesia	2 (6.7)	3 (10.3)	0.33
General anaesthesia/failure of CSE	0 (30)	1 (30)	0.42

Table 6: Incidence of complications.

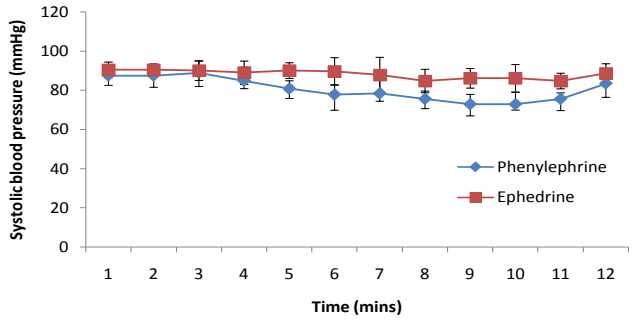

Figure 1: Graph showing systolic blood pressure trend during the spinal injection to delivery interval in the two vasopressor infusion groups.

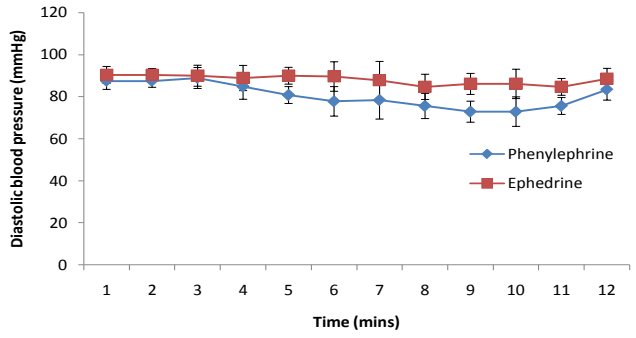

Figure 2: Graph showing diastolic blood pressure trend during the spinal injection to delivery interval in the two vasopressor infusion groups.

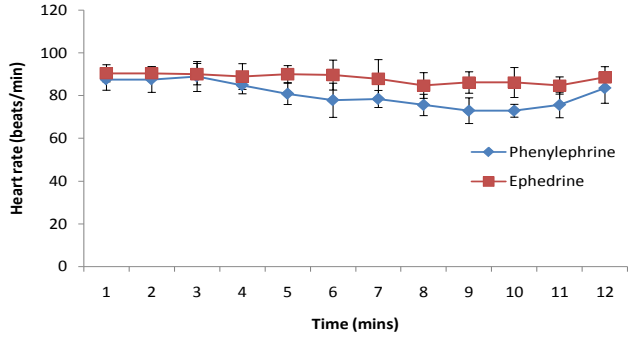

Figure 3: Graph showing heart rate trend during the spinal injection to delivery interval in the two vasopressor infusion groups.

infusion groups from the time of the spinal injection to just after the delivery of the foetus. The chart showed that the heart rate pattern was higher in the Ephedrine group than in the Phenylephrine group.

Discussion

The safety and efficacy of prophylactic intravenous infusions of the vasopressors–phenylephrine and ephedrine during combined spinal epidural anaesthesia for Caesarean section was studied in our parturients. This study showed that, prophylactic intravenous infusions of phenylephrine and ephedrine are effective at reducing the incidence and severity of maternal hypotension during CSE with no associated neonatal acidosis. It also demonstrated that, prophylactic phenylephrine infusion produced a slightly better control of maternal systolic and diastolic arterial blood pressures than ephedrine infusion while maternal heart rate was better maintained by the ephedrine infusion.

Five (8.5%) out of the 59 patients who completed this study developed hypotension. While Adigun et al. [8] reported an incidence of 24.2% in their study using bolus phenylephrine and ephedrine during spinal anaesthesia for Caesarean section, Desalu and Kushimo [9] reported an incidence of 40% in patients who received ephedrine infusion.

A reduction in the magnitude and severity of hypotension was found in both vasopressor groups in this study and confirms the finding that, infusions of vasopresssors are best titrated to maintain blood pressure to near baseline levels [6].While Phenylephrine maintained better systolic and diastolic blood pressures than ephedrine in this study, ephedrine maintained a better heart rate pattern. These haemodynamic effects or findings are in agreement with other studies [8,10,11] indicating that phenylephrine administered as infusion effectively maintains SBP, MAP and DBP, but decreases heart rate during spinal anaesthesia and CSE. NganKee and colleagues [12] demonstrated that in patients receiving spinal anaesthesia for Caesarean section, a prophylactic infusion of phenylephrine 100 μg/min given immediately after initiation of spinal block decreased the incidence, frequency and magnitude of hypotension compared with a control group receiving intravenous bolus of 100 μg phenylephrine given as treatment for episodes of hypotension. The lower dose of phenylephrine used in this study was to ensure a relative potency of 80:1 based on the study by Saravanet al. [13].

The incidence of hypotension during spinal anaesthesia and CSE varies depending on the definition and technique used and has been estimated to be as high as 80% [14] Most studies define hypotension as a mean SBP less than 20-30% of the baseline or an absolute systolic pressure of less than 90-100 mmHg. Adigun et al. [8] defined hypotension as reduction in SBP >30% of baseline value. This study however, defined hypotension as reduction in SBP >20% of baseline value. Whereas Adigun and colleagues used 2.5 ml of 0.5% heavy bupivacaine for spinal anaesthesia, 2.0 ml of 0.5% plain bupivacaine was used with the CSE technique in this study. Although one study2 had shown that the incidence of hypotension was more with the use of 0.5% plain bupivacaine for subarachnoid block, another study by Srivastava et al. [15] suggested that the spread of spinal solution and the incidence of hypotension is not dependent on the baricity of bupivacaine in full term pregnant patients.

The low incidence of hypotension found in this study may have been due to the administration of infusions of vasopressors immediately after the intrathecal injection (before the onset of hypotension), use of CSE which allowed the use of a low dose of local anaesthetic agent, crystalloid pre-loading, 20 degree left uterine displacement and pillow support under the shoulder and head of the parturient on return to supine position. This study also exploited the marginal haemodynamic benefit of crystalloid preloading by using only 1 litre of 0.9% normal saline as preload for all the parturients before induction of the CSE. Fluid co-loading is now being advocated in conjunction with use of vasopressor infusions [6].

The use of CSE may have also contributed to the low incidence and severity of hypotension found in this study. This is so because knowing that the epidural catheter will be there as a 'back-up' if the block is inadequate, indicated the choice of a dose of 2 ml plain bupivacaine for the spinal which is at the 'low end' of the range of possible doses (2-3 ml). This has been established in various studies [16,17] and may have contributed to the safety of the technique, possibly reducing the risk of complications secondary to a high block from too large a spinal dose for the patients. The higher the dose administered, the greater the incidence of hypotension.

The doses of ephedrine and phenylephrine used in this study were equipotent and both agents prevented a fall in the blood pressure, with the phenylephrine infusion group showing a slightly better control than the ephedrine group. It has been demonstrated that intravenous phenylephrine can decrease the rostral spread of intrathecal local anaesthetic by a median of two dermatomes compared with ephedrine [18] Pregnancy is associated with epidural vein engorgement and a reduction in lumbosacral cerebrospinal fluid volume [19]. Cooper et al. [18] speculated that phenylephrine may constrict engorged lumbar epidural veins to a greater extent than ephedrine, thereby increasing the compliance of the epidural space, lowering intrathecal pressure, and reducing the spread of an intrathecal injection and consequently the incidence and severity of hypotension.

Earlier studies of vasopressors in obstetrics focused mainly on differences among agents in their effect on utero-placental blood flow. Animal studies showed that utero-placental blood flow was better maintained with ephedrine compared with α-agonists [4].This finding led to the clinical recommendation that ephedrine should be the vasopressor of choice in obstetric anaesthesia; because greater utero-placental blood flow should correspond to greater oxygen supply to the foetus. However, recent clinical data showed that the use of ephedrine is in fact associated with lower foetal pH and base excess values and has led to the re-appraisal of the older teaching. The higher HR values observed in the ephedrine group in this study may have been due to it β1-adrenoreceptor activity and the over-riding chronotropic effect of ephedrine infusion. Alternatively, the absence of bradycardia could be due to a baroreceptor-mediated reflex tachycardia in response to the reduction in systemic vascular resistance after the induction of spinal anaesthesia.

Analysis of umbilical cord blood gases remains the gold standard for assessment of the newborn [20]. In this present study, all the newborn were also assessed using umbilical artery pH and the Apgar scoring system. Umbilical artery pH and Apgar scores at 1 and 5 minutes were similar in both groups in this study. Similar neonatal outcomes have also been reported in other studies [10,21].

The incidence of nausea and vomiting was one (3.3%) out of 30 patients in the phenylephrine group and none in the ephedrine group. One study [11] reported an incidence of 4.25% for nausea and vomiting while another [9] reported incidences of 41.7% and nil respectively for nausea and vomiting in parturients who received ephedrine infusion during spinal anaesthesia for Caesarean section. One patient in this study had extensive adhesiolysis from previous Caesarean deliveries but did not develop hypotension. This patient also had epidural top-up and surgery lasted for 85 mins. Whereas, nausea and vomiting following spinal anaesthesia frequently follows hypo-perfusion of the chemoreceptor trigger zone following hypotension, this case may have been due to stimulation of the vagus nerve as a result of extensive adhesiolysis and bowel manipulation. This finding contrasts with findings in some other studies [7,17] where the incidence was similar or more in the ephedrine group than in the phenylephrine group. Adigun et al. [8] in a recent study reported nausea in both groups of patients (phenylephrine and ephedrine); the patients also had hypotension.

Post-spinal shivering was the commonest complication in both groups. The incidence was more in the ephedrine group (17.2%) than in the phenylephrine group (10%), the overall incidence being 13.5%. An earlier study [11] found an incidence of 29.8% during Caesarean section. It was treated with warm intravenous fluids, O2 by face mask, covering the patients with warm blankets and reassurance. However, where these measures failed, low dose ketamine 0.25-0.5 mg/kg was used. Potent anti-shivering properties have been attributed to many drugs. These include biogenic monoamines, cholinomimetics, cations, endogenous peptides, opioids and N-methyl-D aspartate (NMDA) receptor antagonists. These agents appear to modulate central thermoregulatory control mechanisms. By NMDA receptor antagonism, low dose ketamine has been demonstrated to be effective at treating post-spinal shivering [22]. Other commonly used agents include meperidine, tramadol and fentanyl.

In conclusion, prophylactic intravenous infusions of phenylephrine and ephedrine were effective at reducing the incidence and severity of hypotension during combined spinal-epidural anaesthesia for Caesarean section without an associated neonatal acidosis. This study showed that phenylephrine infusion administered prophylactically results in better blood pressure and heart rate control than ephedrine infusion. The combined spinal-epidural anaesthesia technique is valuable in patients with anticipated prolonged duration of surgery such as previous Caesarean sections as the epidural catheter can be used to extend the block without recourse to sedation or conversion to general anaesthesia.

Disclosure

The authors received no external funding for this study and have no conflicts of interest to declare.

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