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Maintenance of Arterial Pressure During Spinal Anaesthesia in Caesarean Section – Comparison of Intravenous Phenylephrine Hydrochloride and Ephedrine

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Abstract
Background: *Maternal hypotension is common during spinal anaesthesia for caesarean section. It is usually treated with vasopressors in addition to crystalloid infusion and left uterine displacement. This study was undertaken to compare the effect of phenylephrine and ephedrine for the maintenance of arterial pressure during spinal anaesthesia in caesarean section.*
Methods: *Forty patients in the age group 20-35 years undergoing caesarean section were randomised to receive either phenylephrine 100 µg bolus (Group P) or ephedrine 6mg bolus (Group E) on detection of hypotension (fall in systolic blood pressure <90 mmHg or <20% from the baseline) after spinal anaesthesia. Hemodynamic variables such as heart rate (HR), systolic blood pressure (SBP) and diastolic blood pressure (DBP) were recorded immediately after spinal anaesthesia, then every 2 mins for the first 20 mins and thereafter every 5 mins till the end of surgery. The number of boluses given was also noted. Foetal wellbeing was assessed by Apgar score at 1 and 5 mins after delivery.*
Result: *Group P showed a rapid restoration of blood pressure (both systolic and diastolic) in the 2^{nd}, 4^{th} and 6^{th} minute in a statistically significant manner ($P < 0.05$). But from 8^{th} to 30^{th} minute there was no statistically significant difference in the arterial blood pressure between the two groups. In Group P there was statistically significant reduction in HR ($P < 0.001$). But the requirement of repeated boluses was more in Group P. Regarding neonatal outcome; Apgar score did not show any adverse effect on foetus in both the groups.*
Conclusion: *Phenylephrine and ephedrine are equally efficacious in maintaining arterial pressures during spinal anaesthesia in the caesarean section. Neonatal outcome was equally good in the two groups.*
Keywords: *Spinal anaesthesia, caesarean section, maternal hypotension, vasopressors, phenylephrine, ephedrine, hypotension.*

Introduction

Single shot spinal anaesthesia is the most popular neuraxial technique for caesarean section[1] because of its simplicity, speed of onset and reliability. It has several advantages over general anaesthesia – avoids the need for airway manipulation, decreases the risk of failed intubation and gastric aspiration, avoids use of depressant drugs causing neonatal depression, allows the mother to remain awake and enjoy the birthing experience and less operative blood loss[2]

The most common complication of single shot spinal anaesthesia is hypotension – its incidence reported to be 80-90% or greater depending on the definition used[3,4] It has been defined variably as systolic blood pressure < 100 mm Hg[5,7] or <90 mm Hg[4] or 20%-30% decrease from the baseline values. Anyhow, hypotension is detrimental to both mother and foetus. As uterine vascular bed is a low resistance system which lacks autoregulation, maternal hypotension will result in decreased foetal blood supply leading to foetal hypoxemia and acidosis. For mother, hypotension is usually associated with nausea and vomiting and in severe cases decreased consciousness, pulmonary aspiration, respiratory depression and cardiac arrest.

The severity of hypotension depends on several factors like the height of the sympathetic blockade, position of the parturient, dose of the drug and patient factors like volume status, vascular tone etc.

Several measures are adopted to manage hypotension like rapid infusion of crystalloids (co-loading with 10-20 ml/kg), left uterine displacement (15-20° left lateral tilt to prevent aortocaval compression) and use of vasopressors. The use of sympathomimetic vasopressors has become the most important strategy in maintaining arterial pressures after spinal anaesthesia[6].

Vasopressors commonly used for preventing hypotension are ephedrine, phenylephrine, mephenterimine, metaraminol, methoxamine etc. Animal studies supported use of ephedrine when compared with other vasopressors with better preservation of uteroplacental circulation[13,14]. But recent clinical trials have shown that phenylephrine which is a pure alpha agonist better preserved uteroplacental circulation as shown by improved umbilical artery pH[8-15]. Ephedrine appears to contribute to foetal acidosis by crossing the placenta and increasing foetal metabolic activity[20], but the risk of true foetal acidosis (pH < 7.2) was not found. As it is a pure alpha agonist without beta action, phenylephrine maintained arterial blood pressure without increasing heart rate. In fact it produced a reflex bradycardia in response to the increased vascular tone. So it is preferred over ephedrine when maternal tachycardia is a concern.

The present study was undertaken to compare the effect of phenylephrine and ephedrine for the maintenance of arterial pressure during spinal anaesthesia in caesarean section.

Materials and Methods

This double bind randomised controlled trial was done after obtaining approval from institutional ethical committee during the period from August to October 2006. Written informed consent was obtained from all the patients in the study.

The study group included 40 ASA I/II patients in the age group 20-35 years undergoing elective as well as emergency caesarean section under spinal anaesthesia. They were randomly allocated into 2 groups of 20 each.

Group P – received bolus phenylephrine 100µg on detection of hypotension after spinal anaesthesia

Group E – received bolus ephedrine 6mg on detection of hypotension after spinal anaesthesia

To make the study double blind the drugs were prepared in similar syringes by another anaesthetist who was not involved in the subsequent patient care.

Exclusion criteria included ASAIII/IV, uncontrolled hypertension, diabetes, heart disease or other major systemic illnesses, spinal deformities, height < 150 cm and foetal distress.

All the patients included in the study underwent a detailed preanaesthetic evaluation. Baseline heart rate and blood pressure (both systolic and diastolic) were recorded.

All the patients were premedicated with inj. Metoclopromide 10mg and Ranitidine 50mg

intravenously within half an hour before surgery. All of them were preloaded with Ringer Lactate 10ml/kg.

On the operating table ECG, NIBP and SPO_2 monitors were attached and baseline HR, SBP and DBP were recorded. After turning the patient to right lateral position, lumbar puncture was done under strict aseptic precautions with 23G quincke needle. After confirming free flow of CSF 1.8ml 0.5% Bupivacaine heavy was injected. The patient was then turned to supine position with a left lateral tilt of 15-20°. Rapid infusion of crystalloids 10-15 ml/kg and supplemental oxygen 5 l/min via face mask were given. HR, SBP and DBP were recorded immediately after turning the patient supine. Whenever hypotension (fall in SBP < 90 mmHg or < 20% of baseline) was detected, bolus dose of vasopressor was given (either phenylephrine 100µg or ephedrine 6mg depending on the study group – Group P or E respectively). HR, SBP and DBP were monitored meticulously every 2 mins for 20 mins and thereafter every 5 mins till the end of surgery. Duration of study was limited to 30 mins after subarachnoid block. The number of boluses required to treat hypotension was also noted. After delivery Oxytocin 5U was given as a slow intravenous bolus followed by an infusion of 20U in 500ml isotonic saline. The incision delivery time was noted. Highest level of sensory block was assessed by pin prick method 5 mins after subarachnoid block.

Apgar scores were assessed at 1 and 5 mins after delivery by the paediatrician who was also blinded to the patient groups. A double clamped segment of umbilical cord was kept for immediate blood gas analysis in case Apgar score was less than 7.

Data were analysed using computer software SPSS. Student's t-test was performed as parametric test to compare different variables. For all statistical evaluations, a two-tailed probability value (p-value) < 0.05 was considered significant.

Results

All values were expressed as mean ± SD. The results analysed are as follows.

Both the groups were comparable with respect to demographic profiles (Table 1) such as age, weight and height ($p > 0.05$).

They were also comparable with regard to other variables like level of sensory blockade, incision delivery time, duration of surgery, indication for caesarean section etc.

The baseline HR, SBP and DBP were also comparable in the two groups ($p > 0.05$). HR, SBP and DBP recorded immediately after spinal anaesthesia, then every 2 mins for 20 mins, and thereafter every 5 mins till 30 mins is shown in Table 2.

Both systolic and diastolic blood pressure decreased from baseline immediately after spinal anaesthesia in both groups and then increased after the bolus dose of vasopressor. Group P (phenylephrine) showed a rapid restoration of SBP and DBP in the 2^{nd}, 4^{th} and 6^{th} min in a statistically significant manner ($p < 0.05$). But from 8^{th} min to 30^{th} min the rise in blood pressure was not statistically significant between the two groups($p > 0.05$).

Table 1 Comparison of Demographic Profiles between Group P and E

Profile	Group P	Group E	t-value	p-value
Age	28.1±3.64	27.7±3.31	0.364	0.718
Height (cm)	155±2.08	155.5±2.04	0.768	0.447
Weight (kg)	56.3±1.89	56.3±2	0.000	1

Table 2 Changes in SBP, DBP and HR in Group P and E

Parameter	Systolic Blood Pressure			Diastolic Blood Pressure			Heart Rate		
	Group P	Group E	p-value	Group P	Group E	p-value	Group P	Group E	p-value
Baseline	123.3±7.03	123.35±8.83	0.984	80.5±5.76	83.2±7.30	0.202	99.2±9.3	93.65±11.86	0.099
Immediately after Spinal	92.0±6.77	91.1±6.0	0.659	64.0±5.19	65.4±5.51	0.413	118.4±11.64	10.9.4±8.61	0.008
2 min	114.3±4.60	98.9±9.36	0.000	80.7±6.72	69.0±7.88	0.000	81.55±13.47	117.6±7.47	0.000
4 min	112.2±5.73	106.4±9.38	0.049	79.4±5.73	70.4±7.24	0.000	82.25±9.41	111.8±7.81	0.000
6 min	110.7±6.27	106.9±9.32	0.047	76.6±5.32	69.6±7.10	0.001	86.6±14.47	109.5±7.84	0.000
8 min	104.5±8.68	110.1±9.07	0.053	73.8±7.67	69.2±6.94	0.054	86.20±11.29	107.6±6.7	0.000
10 min	107.5±7.04	110.9±7.83	0.157	72.5±5.06	70.1±6.33	0.076	83.50±10.86	105.8±7.22	0.000
12 min	107.7±9.92	112.0±6.77	0.143	73.3±7.79	71.15±6.5	0.349	81.10±12.89	105.8±6.77	0.000
14 min	110.6±5.55	111.3±7.60	0.741	75.5±6.74	70.5±6.08	0.076	75.00±9.14	105.5±5.95	0.000
16 min	107.6±7.64	111.8±7.22	0.082	71.7±5.70	70.4±5.20	0.190	78.95±9.20	104.2±6.29	0.000
18 min	107.3±7.32	110.6±8.36	0.192	71.9±5.09	69.5±5.22	0.054	77.60±12.89	105.1±5.86	0.000
20 min	107.4±6.39	111.7±6.75	0.068	72.6±5.66	70.5±5.16	0.190	78.85±11.70	104.5±6.01	0.000
25 min	108.0±6.52	111.7±7.12	0.095	73.6±7.18	71.3±5.27	0.349	77.00±9.41	104.4±6.67	0.000
30 min	108.5±4.39	111.8±6.45	0.066	73.1±5.89	71.2±4.96	0.190	77.20±8.79	104.1±6.31	0.000

Table 3 Bolus drug required

Bolus Drug Required	Group P		Group E	
	No. of patients	% of patients	No. of patients	% of patients
One	5	25	11	55
Two	9	45	8	40
Three	6	30	1	5

Table 4 Apgar Scores

Apgar Score	Group P	Group E	t-value	p-value
1 min	8.85 ± 0.37	8.80 ± 0.41	0.406	0.687
5 min	9.85± 0.37	9.80 ± 0.41	0.408	0.684

There was an increase in heart rate in both the groups immediately after spinal anaesthesia. In Group P, heart rate reduced from the 2nd min after the bolus dose and remained like that until the end of study. This was highly significant statistically ($p < 0.001$). In Group E, the heart rate remained almost always elevated than the baseline.

Regarding the number of boluses required to maintain blood pressure, in Group P, 25% required single, 45% required two and 30% required 3 boluses. Whereas in Group E, 55% required single, 40% required two and only 5% required 3 boluses (Table 3).

Apgar scores did not reveal any untoward effect on foetal status since all the newborns of the two groups had Apgar scores<8 (Table 4.).

Discussion

Our study has also shown that use of vasopressors are the mainstay in treating hypotension due to spinal anaesthesia in caesarean section[6]. In our study, we had preloaded our patients with 10ml/kg Ringer Lactate before giving spinal anaesthesia. Other non-pharmacological measures like left uterine displacement and oxygen supplementation were also given. However, vasopressors were needed to maintain blood pressure adequately.

Even though animal studies supported use of ephedrine, recent clinical trials have shown the efficacy of phenylephrine in treating hypotension[16-18] Our study has also proved that phenylephrine showed a rapid restoration of systolic and diastolic blood pressures compared to ephedrine. But the requirements of repeated boluses were more with phenylephrine compared to ephedrine. In addition phenylephrine has got a heart rate lowering effect whereas ephedrine showed a heart rate raising tendency.

But none of the two vasopressors was found to have adverse effects on foetus as assessed by Apgar

scores. In our study, the umbilical artery pH was not done as none of the babies had Apgar scores < 7.

Conclusion

We conclude that both phenylephrine and ephedrine are equally efficacious in maintaining arterial pressures during spinal anaesthesia in caesarean section. Neonatal outcome was equally good in the two groups.

Even though phenylephrine showed a rapid onset of action compared to ephedrine, the offset was also rapid requiring more number of boluses. The heart rate lowering effect of phenylephrine is advantageous in situations where maternal tachycardia is undesirable.

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