RESEARCH PAPER | Medical Science | Volume : 5 | Issue : 2 | Feb 2015 | ISSN - 2249-555X

Comparison of Intravenous Bolus Ephedrine Phe-Nylephrine and Mephentermine for Maintenance of Arterial Pressure During Spinal Anaesthesia in Caesarean Section

KEYWORDS: phenylephrine, ephedrine, mephentermine , blood pressure, heart rate,

Dr.D.V.Rama Siva Naik
Assistant Professor, Dept. of Anaesthesiology, Kurnool Medical College, Kurnool,

Dr.Murali Prabhakar
Assistant Professor, Dept. of Anaesthesiology, Kurnool Medical College, Kurnool,

ABSTRACT *Context: Comparison of intravenous bolus ephedrine phenylephrine and mephentermine for maintenance of arterial pressure during spinal anaesthesia in caesarean section.*

AIM: To Comparison of intravenous bolus ephedrine phenylephrine and mephentermine for maintenance of arterial pressure during spinal anaesthesia in caesarean section.

Settings and Design: The present Prospective Randomizedstudy was carried out in a tertiary care teaching hospital. A total of 60 American society of Anaerianearnesthesiologist physical status I and II paients aged about 20 to 30 Years pregnant women posted for elective cease-ran and emergency ceaserian section under spinal anaesthesia were enrold in the study. Pa-tients were randomly devided in to three groups. Group P (phenylephrine) Group E (ephe-drine) Group M (mephentermine) with 20 patients in each group.

Materials and Methods: group P received 100 ug I v bolus Group E received ephedrine 6 mg I v bolus and group M 6mg in 1ml I v bolus.

Statistical Analysis Used: Comparitibility of groups are analyzed with analysis variance test to analyzed parametric data 'P' value < 0.05 was considered significant.

Results: The systolic and diastolic arterial pressure were decreased statistically significant (P<0.001) at the onset of Hypotension and increases after bolus dose of drug , in all the three groups heart rate variable in deferent groups in pre and post surgery drug values.

Conclusion: we have found that the phenylephrine, ephedrine and mephentermine are ef-fective in I v bolus form in maintanace of arterial pressure within 20% limit of base line though phenylephrine has quicker peak effect in coparission to ,ephedrine and mephenter-mine and it causes reduction in heart rate which may be advantageous in cardiac patients and patientsin whom tachycardia is undesirable.

INTRODUCTION

The Regional anaesthetic techniques used for caesarean section have gained increasing popularity during the past few decades. The main impetus has come from the women themselves. Most mothers wish to be awake during the delivery. Furthermore the reduction in maternal morbidity and mortality in the recent years has been attributed to the increased use of regional anesthesia. The NSCSA (National Sentinel Caesarean Section Audit) 2001 reported that 77% of emergency and 91% of elective caesarean sections are being performed using regional anaesthesia.

Although regional anaesthesia offers several definite advantages, it has its potential complications, which may cause maternal morbidity and mortality. Maternal hypotension remains one of the most common complications during the application of regional techniques.

Anaesthesia to a parturient is not only unique but requires highest degree of care because the Anaesthesiologist has to look after two individuals, the mother and foetus.

In elective caesarean section under regional anaesthesia hypotension has been reported in as many as 85% of patients.

Hypotension may be detrimental to the mother and in foetus it results in placental hypoperfusion. Careful positioning and volume preloading with crystalloids or colloids have been used to prevent it, but these are not complete measures and Vasopressor is required to correct hypotension quickly. We have studied intravenous boluses of Phenylephrine, Ephedrine and Mephentermine for maintenance of arterial pressure during spinal anaesthesia in caesarean section.

METHODOLOGY

Approval from the ethical committee of the College and informed consent from each patient were taken. We studied 60 patients, singleton full term pregnant patients undergoing elective as well as emergency Caesarean sections, who developed hypotension after subarachnoid block (SAB). They were of 20-30 yrs of age with ASA Group I and II and divided into 3 groups of 20 each as per study drugs:

Group P: Phenylephrine 100ug.
Group E: Ephedrine 6mg and
Group M: Mephentermine 6mg in 1 ml as bolus IV.

Each patient received intramuscular Inj. atropine 0.6, mg, and 30-45min before anaesthesia. Ryles tube suction was done, who were not nil oral for 4 hrs, Ringer's lactate solution 10mlkg-1 was infused rapidly as preload. The patients were connected to noninvasive sphygmomanometer and ECG monitor with modified chest leads. With careful antiseptic preparation and patients in the lateral position, 1.2ml of Lignocaine 5% with two drops of adrenaline was administered in subarachnoid space through a 23 gauze Quincke needle at either L2-3 or L3-4 space. The patient

Volume : 5 | Issue : 2 | Feb 2015 | ISSN - 2249-555X

was turned to supine position and after 5 min wedge was placed under the right flank. Oxygen was administered at a rate of 4L min-' by a face mask to all the patients until the umbilical cord was clamped. And Inj. Oxytocin 20U in 5% dextrose was given after clamping the cord.

After preloading, pulse rate, systolic and diastolic arterial pressures were recorded thrice then the middle values were taken as base line values. Then same parameters were recorded after subarachnoid block, then at every 2 min for 20 min and thereafter every 10 min until the end of the surgery. Whenever hypotension (fall in systolic pressure >20% from the baseline value or a value less than 90mmHg) occurred the study drug was given as IV bolus. The number of boluses and time taken to develop hypotension were noted.The bradycardia i.e. a pulse rate of 60min-1 or less was treated with atropine 0.3mg I.V.

The highest level of sensory block was assessed by pin-prick method 5min after the sub arachnoid block. The induction delivery and incision delivery interval were recorded. Paediatrician assessed Apgar score of every neonate at 1 and 5min after delivery.

Comparability of groups were analysed with Analysis variance (ANOVA) test. Student's two-tailed 't' test applied to analyse parametric data. P value < 0.05 was considered significant.

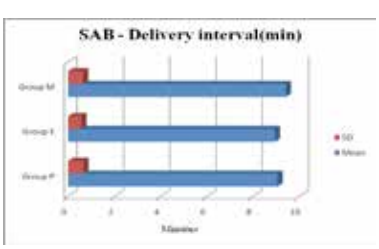
OBSERVATIONANDRESULTS

The groups were comparable in physical characteristic. All the three groups were similar in sensory block level, time to develop hypotension and mean time to delivery and uterine incision to delivery interval.

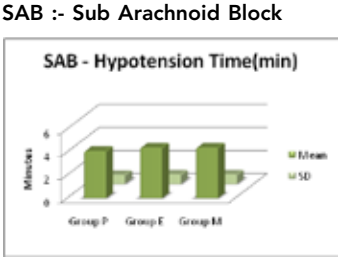
Table — 3: Patients characteristic and relevant data

	Group P (Phenylephrine) 23.15+ 2.24	Group E (Ephedrine) 22.85+2.39	Group M (Mephentermine) 23.9+ 2.56
Maternal age(Mean± SD) years	23.15 ± 2.24	22.85 ± 2.39	23.9 ± 2.56
Maternal weight(Mean ±+ SD) kgs	63.5+3.00	63.2 ± 2.94	64 ± 3.09
Maternal Height(Mean ±+ SD) cms	154.3± 4.37	154.9 ± 5.27	156.7 ± 5.09
Highest level ofsensory blockade (Median)	T6	T6	T6
SAB-Hypotension time (mean ± SD) min	4.1 ± 0.76	4.4 ± 0.8	4.4 ± 0.8
SAB - Del interval(Mean ±+ SD) min	9.05 ± 0.67	8.95 ± 0.58	9.4 ± 0.66
U1 – Del interval(Mean ± SD) min	1.1 ± 0.3	1.15 ± 0.35	1.05 ± 0.21
Foetal Heart rate(Mean ± SD) per minute	136.2 ± 2.18	134.9 ± 0.99	135.3 ± 1.70810
APGAR Score of baby(median) At 1 minute At 5 minutes	8 10	8 10	8 10

SAB :- Sub Arachnoid Block



Graph 1
SAB :- Sub Arachnoid Block



Graph 2

The systolic and diastolic arterial pressures were decreased statistically significant (p<0.001) at the onset of hypotension and increased after bolus dose of drug, in all the three groups. On inter group comparison rise of systolic blood pressures at 2, 4, 6, 8 and l0 minutes post study drugs were less in Ephedrine and Mephentermine groups as compared to phenylephrine78 group (p<0.001). And at 4 min post study drug systolic blood pressure was significantly less in Ephedrine group as compared to Mephentermine group. At the end of surgery all the three groups recorded almost equal systolic pressures. Diastolic blood pressures at 2, 4, 6 and 8 minutes were significantly less in ephedrine and mephentermine groups than the phenylephrine86 group (p<0.001). Diastolic blood pressures were slightly more with ephedrine group compared to mephentermine group at 6 and 8 minutes after drug given.

Volume : 5 | Issue : 2 | Feb 2015 | ISSN - 2249-555X

Table-4 : Changes in Systolic blood pressure (Mean ++SD) mm of Hg

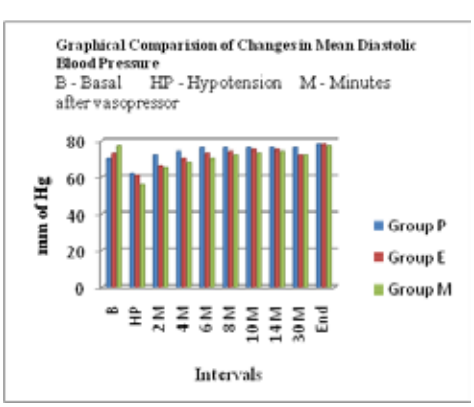
Intervals	Systolic Blood pressure (mm Hg)			Inter group comparison P-E P-M		
	Group P	Group E	**Group** M	P-E	P-M	E-M
HP(VP given)	83.8±7.56	83.4±8.72	83.2 ± 7.35	-	-	-
2 min after V P	108.9*± 8.37	91.4*± 6.29	92.4*±3.49	++	++	-
4 min after VP	113.1* ± 6.24	99.6*±3.72	103.1* ± 5.45	+	+ + I i	+
6 min after VP	115.1* ± 4.07	106.8* ± 3.37	106*± 4.81	+	++	-
8 min after VP	116.5*±4.18	110.5*± 3.57	107.8*±7.03	++	++	-
10 min after VP	116.7* ± 4.30	111* ±7.78	111*± 4.17	++	++	-
14 min after VP	114* ± 9.93	112.6* ± 7.35	110.8*± 7.67	-	-	-
At 30 min of surgery	114.3* ± 7.72	108.1*±12.96	105.6*± 14.73	-	-	-
At the end of the surgery	117.1* ± 3.43	117.4* ± 3.85	117.4*± 3.8	-	-	-

HP-Hypotension VP-Vasopressor agents
With in the groups values were compare between HP values and post VP With in the groups :Between the groups
++ P< 0.001 * P <0.05 + P<0.05 0 P > 0.05 - P>0.05

Table-5 : Changes in diastolic blood pressure (Mean + SD) mm of Hg

Intervals	Diastolic Blood pressure (mm Hg)			Inter group comparision		
	Group P	Group E	**Group** M	P-E	P-M	E-M
HP(VP given)	62.4±8.91	61.2 ± 8.15	56.9 ± 6.76	-	+	+
2 min after VP	72.7*±3.80	66.1*±5.49	65.55*± 4.63	++	++ ++	-
4 min after VP	74.5*±2.59	70.1*±4.17	68.8*±3.48	++	++	-
6 min after VP	76.2*±1.88	73.3*±2.55	70.8*±2.92	+	++	+
8 min after VP	76.4*±2.24	74.5*±1.98	72*±4.19	+	++	+
10 min after VP	76.8*±2.71	75.6*±2.57	73.8*±5.45	-	+	-
14 min after VP	76*±3.94	75.6*±3.26	74.0*±5.69	-	-	-
At 30 min of surgery	76.7*±4.16	72.9*±6.70	72.1*±+8.75	-	-	-
At the end of thesurgery	78.1±+1.94	78.5*±1.53	77.8*±2.44	-		-

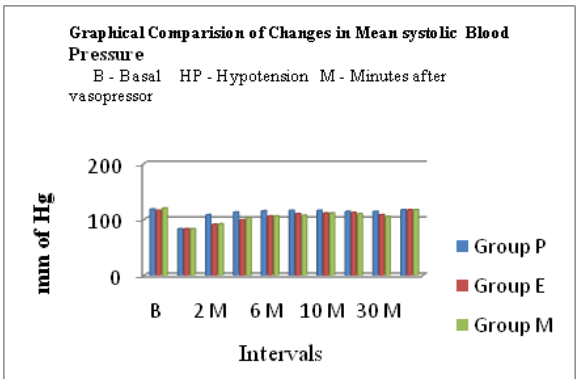
HP-Hypotension VP-Vasopressor agents
With in the groups values were compare between HP values and post VP With in the groups :Between the groups
++ P< 0.001
* P <0.05 + P<0.05
0 P > 0.05 - P>0.05



Graph 3

Volume : 5 | Issue : 2 | Feb 2015 | ISSN - 2249-555X

In group P, post study drug values of heart rate were decreased significantly from the values at onset of the hypotension till end of the surgery. Whereas in group E, post study drug values remained high upto 30 min ($p>0.05$) and then decreased from the value of onset of hypotension ($p<0.05$). In group M, heart rates were high after study and drug values remained statistically non significant with values at onset of the hypotension till end of the surgery.

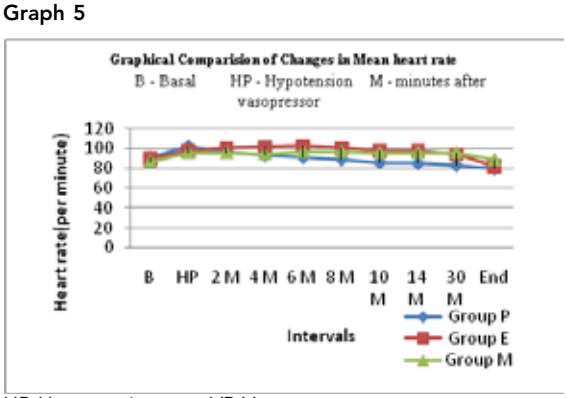


Graph 4

table-6: Changes in Heart rate (Mean + SD)

Intervals	Heart rate (per minute)			Inter group Comparision P-E	Inter comparisoin P-M	
	Group P	Group E	Group M	P-E	P-M	E-M
HP(VP given)	102.35±9.48	98.9 ±7.42	96.1 ±5.81	-	+	-
2 min after VP	97.20*±7.10	101.15* ±9.45	96.5*±+8.21	-	-	-
4 min after VP	93.75*±7.17	102.35 * ±10.95	95.85 * 8.10	+	-	+
6 min after VP	91.70*±7.23	103.5 * ±12.98	97.65 * 2.32	+	-	-
8 min after VP	89.7*±8.77	101.95* ±8.47	97.1 * ±12.48	++	+	-
10 min after VP	86.35*±10.62	98.7* ±13.83	96.7* ±10.46	+	+	_
14 min after VP	85.50*±5.29	98.6 * ±6.34	96.35* ±14.52	++	+	_
At 30 min of surgery	83.90*±6.67	94.75* ±5.37	96.3 *±9.67	++	+	_
At the end of the surgery	80.85*±3.02	82.95* ±3.79	89.85* ±5.72	-	++	++

Graph 5



HP-Hypotension VP-Vasopressor agents

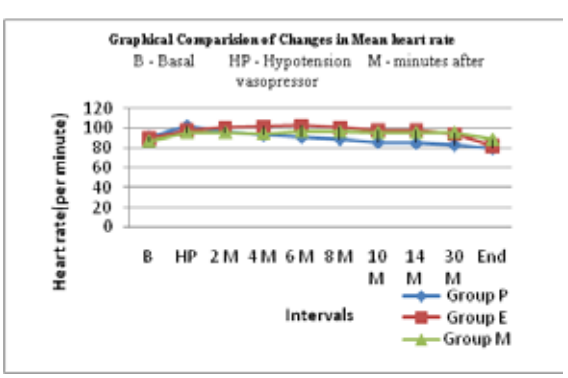
With in the groups values were compare between HP values and post VP With in the groups :Between the groups

++ P< 0.001
* P <0.05 + P<0.05
0 P > 0.05 - P>0.05

In group P, 80% patients required single bolus dose while 15% two and 5% three to maintain systolic pressure within 20% limit of basal value. In group E, 45% required single, 45% two and 10% three bolus doses. Whereas in group M, 55% required single, 40% two and 5% three doses.

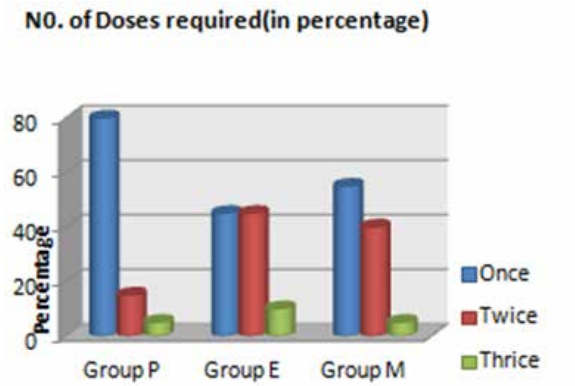
One patient (5%) in each group developed bradycardia. In group P & E, 10% patients developed nausea and vomiting.

Apgar score did not reveal any untoward effect on foetal status since all new born of three groups had Apgar score greater than 7.



Graph 6

Volume : 5 | Issue : 2 | Feb 2015 | ISSN - 2249-555X



Graph 7

DISCUSSION

After subarachnoid block for caesarean section, hypotension can be minimized by the use of IV fluid preload, avoidance of aortocaval compression and judicious use of a vasopressor agent. It has been shown that the percentage decrease in placental perfusion is related to the percentage reduction in maternal arterial pressure and not to the absolute reduction in pressure. For the purpose of this study, hypotension was defined as a decrease in arterial pressure greater than 20% from baseline systolic pressure.

Ephedrine and Mephentermine have got a mixed action directly as well as indirectly on alpha and beta receptors, whereas Phenylephrine has pure alpha receptor activity. Thomason and Colleagues reported that bolus Phenylephrine 100mcg is as effective as ephedrine 5mg restoring maternal arterial pressure above 100mmHg. Moran and colleagues gave ephedrine 10 mg or Phenylephrine 80 mcg IV bolus to maintain systolic arterial pressure above 100mmHg. They concluded that Phenylephrine is as effective as ephedrine and when used in small incremental bolus injections, it appears to have no adverse neonatal effects in healthy, non laboring parturient. Ramanathan and Colleagues studied in 127 healthy patients undergoing elective caesarean section under epidural anaesthesia. They concluded that transient maternal hypotension does not affect neonatal acid – base status, both ephedrine and Phenylephrine increase cardiac preload and agent like Phenylephrine does not cause foetal acidosis, when used for treating maternal hypotension.

In this study all the three vasopressor effectively maintained arterial pressure within 20% limit of baseline value though Phenylephrine maintained better in first 6min of bolus dose as compared to ephedrine and Mephentermine. This may be due to that, Phenylephrine has peak effect within one minute, whereas ephedrine has 2-5min and Mephentermine has 5min.

In our study Phenylephrine causes significant reduction in heart rate after the bolus dose, which is a consistent effect in Phenylephrinc treated women in other studies also. In spinal anaesthesia, since there is decreased venous return, decreased venous pressure and a decreased right heart pressure thus slowing of the heart rate is expected on the basis of the Brain-bridge reflex. Bradycardia is also expected in high spinal, probably due to some paralysis of the cardiac accelerator nerve. we found that the maternal heart rate was slower with Phenylephrine than with ephedrine and Mephentermine because Phenylephrine lacks action on the beta receptors.

CONCLUSION

We have found that the Phenylephrine,Ephedrineand Mephentermine are effective in IV bolus form in maintenance of arterial pressure within 20% limit of baseline though Phenylephrine. has quicker peak effect in comparision to Ephedrine & Mephentermine and it causes reduction in heart rate, which may be advantageous in cardiac patients and patients in whom tachycardia is undesirable.

Volume : 5 | Issue : 2 | Feb 2015 | ISSN - 2249-555X

REFERENCE

1. Riley ET.Cohen SE,Rubenstein AJ, Flanagan B. Prevention of hypotension after spinal anaesthesia for caesarean section: 6% hetastarch versus lactated Ringer's solution. Anesth Analg 1995: 81: 838-42. | | 2. Jackson R, Reid JA, Thorburn J. Volume preloading is not: essential to prevent spinal induced hypotension at caesarean section. Br J Anaesth 1995; 75: 262 – 5. | | 3. Karinen J, Rasonen J, Alahuhta S, Jouppila R and Jouppila P. Effect of crystalloid and colloid preloading on uteroplacental and maternal haemodynamic state during spinal anesthesia for caesarean section. Br J Anaesth 1998; 531-35. | | 4. Corke BC, Dutta S, Ostheiner GW, Weiss JB, Alper MH. Spinal anaesthesia for caesarean section. The influence of hypotension on neonatal outcome. Anesthesia 1982; 37: 658 – 662. | | 5. Thomson DG, Robson SC, Redfern N, Hughes D, Boys RJ. Rando-mized trial of bolus Phenylephrine or Ephedrine for maintenance of arterial pressure during spinal anesthesia for caesarean section. Br J Anaesth 1996; 76: 61 – 5. | | 6. Moran DH, Dutta S, Perillo M, Laporta RF, Bader A. Phenylephrine in the prevention of hypotension following spinal anaesthesia for caesarean delivery. J. Clin.Anaesth 1991;3(4)301 –5. | 7. Ramanathan S, Crant G.J. Vasopressor therapy for hypotension due to epidural anaesthesia for caesarean section. Acta Anaesthesiol Scand 1988; 32: 559-565. | 8. Hall PA, Bennet A, Wilkes M.P., Lewis M.Spinal anaesthesia for caesarean section: comparison of infusions of Phenylephrine and Ephedrine. Br J Anaesth 1994; 73: 471-4. | 9. Sota Omoigui. Drugs. In: Anaesthsia Drugs Handbook. Bangalore: Panther Pub-lishers Pvt Ltd, 2000; 146: 258, 346. | | 10. Dinesh Sahu, Dileep Kotari: Comparison of bolus phenylephrine ,ephedrine for maintenance of arterial pressure during spinal anesthesia in caesareansection.Indian J.Anaesth,2003;47(2);125-128. | | 11. Pernoll ML, Mandell JE. Caesarean | section. Chapter 30, Principles and Practice of Obstetric Analgesia and Anaes-thesia,2nd Edn., Bonica JJ and McDonald JS, Williams and Wilkins, 1995:968-1009. | 12. Clyburn P. Spinal anaesthesia for caesarean section: time for reappraisal? (Editoria) Anaesthesia 2005;60:633-3. | 13. Parameshwara G. Spinal, epidural to | combined spinal epidural analgesia. The | history of central neuraxial block. Indi | an Journal of Anaesthesia | 2001;45(6):406. | 14 Greene NM, Brull SJ. Pulmonary ventilation and hemodynamics, Chapter 3, | Physiology of Spinal Anaesthesia, 4th Edn., Baltimore, Williams and | Wilkins, 1993;201-24. | 15. Eloner H, Barcohana J, Bartosheck AK. Influence of postsponal hypotension | on fetal electrogram.American Journal of Obstetrics and Gynaecology 1960; | 80: 560 -72. [6] Corke BC, Datta S, Ostheinar GW. Spinal anaesthesia for | caesarean section. The influence of hypotension on neonatal outcome. | Anaesthesia 1982;37:658-62. | 16. Jackson R, Reid JA, Thorburn J. Volume preloading is not essential to prevent | spinal Induced hypotension at caesarean section. British Journal of | Anaesthesia1999;35:364-9. | 17. Sahu D, Kothari D, Mehrotra A. Comparison of Bolus Phenylephrine, | Ephedrine, and Mephentermine for maintenance of arterial pressure during | spinal anaesthesia in caesarean section – a clinical study. Indian J Anaesth | 2003;47(2):125-8. | 18. Ngan Kee WD, Khaw KS, Lee BB, Lau TK, Gin T. A dose response study of | prophylactic intravenous ephedrine for the prevention of hypotension during | spinal anaesthesia for Caesarean delivery. Anaesthesia and Analgesia 2000; | 90: 1390 - 5. | 19. Rout Cc, Akoojee SS, Rocke DA, Gouws E. rapid administration of | crystalloid preload does not decrease the incidence of hypotension after spinal | anaesthesia for elective Caesarean section. British Journal of Anaesthesia | 1992;68:394-7. | 20. Rout CC, Rocke DA, Levin J, Gouws E, Reddy D. A reevaluation of the role | of crystalloid preload in the prevention of hypotension associated with spinal | anaesthesia for elective Caesarean section.Anaesthesiology 1993;79:262-9. | 21. Thomas DG, Robson SC, Redfern N, Hughes D, Boys RJ. Randomized trial of | bolus phenylephrine or ephedrine for maintenance of arterial pressure. During | spinal anaesthesia for caesarean section. British Journal of Anaesthesia | 1992;46:21-3. | 22. Moran DH, Dutta S, Perillo M, Laporta RF, Bader A. Phenylephrine is the | prevention of hypotension following spinal anaesthesia for caesarean delivery. | Journal of Clinical Anaesthesia 1988;3(2):227-2. | 23. Ramanathan S, Grant GJ. Vasopressor therapy for hypotension due to epidural | anaesthesia for caesarean section. Acta Anaesthesiol Scand 1993;82:342 -80. | 24. Hall Pa, Bennett A, Wikes MP, Lewis M. Spinal anaesthesia for caesarean | section.Comparison of infusion of phenylephrine and Ephedrine. British | Journal of Anaesthesia 1994;73:471-4. | 25. Taylor JC, Tunstall ME. Dosage of phenylephrine in spinal anaesthesia for | caesarean section. Anaesthesia 1991;46:314-5. 1. Rout CC, Rocke DA. | Prevention of hypotension following spinal anesthesia for cesarean section. | Int Anesthesiol Clin 1994;32:117–35. | 26. Rout CC, Rocke DA, Levin J, et al. A reevaluation of the role of crystalloid | preload in the prevention of hypotension associated with spinal anesthesia for | elective cesarean section. Anesthesiology 1993;79:262–9. | 27. Burns SM, Cowan CM,Wilkes RG. Prevention and management of hypotension | during spinal anaesthesia for elective caesarean section: a survey of practice. | Anaesthesia 2001;56:777–98. | 28. Ralston DH, Shnider SM, DeLorimier AA. Effects of equipotent | ephedrine,metaraminol, mephentermine, and methoxamine on uterine blood | flow in the pregnant ewe. Anesthesiology 1974;40:354–70. | 29. James FM III, Greiss FC Jr, Kemp RA. An evaluation of vasopressor | therapy for maternal hypotension during spinal anesthesia. Anesthesiology | 1970;33:25–34. | 30. Alahuhta S, Ra¨sa¨nen J, Jouppila P, et al. Ephedrine and phenylephrine for | avoiding maternal hypotension due to spinal anaesthesia for caesarean section. | Int J Obstet Anesth 1992;1:129–34 | 31. Thomas DG, Robson SC, Redfern N, et al. Randomized trial of bolus | phenylephrine or ephedrine for maintenance of arterial pressure during | spinal anaesthesia for caesarean section. Br J Anaesth 1996;76:61–5. | 32. Hall PA, Bennett A,Wilkes MP, Lewis M. Spinal anaesthesia for caesarean | section: comparison of infusions of phenylephrine and ephedrine. Br J Anaesth | 1994;73:471–4. | 33. Moran DH, Perillo M, LaPorta RF,et al. Phenylephrine in the prevention of | hypotension following spinal anesthesia for cesarean delivery. J Clin Anesth | 1991;3:301–5. | 34. Lefebvre C, Clarke MJ. Identifying randomised trials. In:Egger M, Davey Smith | G, Altman DG, eds. Systematic reviews in health care. London:BMJ Publishing | Group, 2001:69 – 86. | 35. Pierce ET, Carr DB, Datta S. Effects of ephedrine and phenylephrine on | maternal and fetal atrial natriuretic peptide levels during elective cesarean | section. Acta Anaesthesiol Scand 1994;38:48–51. | 36. LaPorta RF, Arthur GR, Datta S. Phenylephrine in treating maternal | hypotension due to spinal anaesthesia for caesarean delivery: effects on | neonatal catecholamne concentrations,acid base status and Apgar scores. | Acta Anaesthesio Scand1995;39: 901–5. | 37. Ayorinde B, Buczkowski P, Brown J, et al. Evaluation of pre emptive | intramuscular phenylephrine and ephedrine for reduction of spinal | anaesthesia-induced hypotension during caesarean section. Br J Anaesthesia | 2001;86:372–6. | 38. Schulz KF, Chalmers I, Hayes RJ, Altman DG. Empirical evidence of bias: | dimensions of methodological quality associated with estimates of treatment | effects in controlled trials. JAMA :1995;273:408–12. | 39. Mosteller F, Colditz GA. Understanding research synthesis (meta-analysis). | Annu Rev Public Health 1996;17:1–23 6. Ramanathan S, Grant GJ. Vasopressor | therapy for hypotension due to epidural anesthesia for cesarean section. Acta Anaesthesiol | Scand 1988;32:559–65. | 40. Roberts SW, Leveno KJ, Sidawi JE, et al. Fetal acidemia associated with | regional anesthesia for elective cesarean delivery. Obstet Gynecol | 1995;85:79–83. | 41. Robson SC, Boys RJ, Rodeck D, Morgan B. Maternal and fetal haemodynamic | effects of spinal and extradural anaesthesia for elective caesarean section.Br J | Anaesth 1992:68:54–9. | 42. Stoelting RK. Pharmacology and physiology in anesthetic practice. | Philadelphia: Lippincott-Raven, 1999. | 43. Ngan Kee WD, Lau TK, Khaw KS, Lee BB. A comparison of metaraminol and | ephedrine infusions for maintaining arterial pressure during spinal anesthesia for | elective cesarean section.Anesthesiology 2001;95:307–13. | 44. Hughes SC, Ward MG, Levinson G, et al. Placental transfer of ephedrine does | not affect neonatal outcome. Anesthesiology 1985;63:217–9. | 45. Corke BC, Datta S, Ostheimer GW, et al. Spinal anaesthesia for caesarean | section: the influence of hypotension on neonatal outcome. Anaesthesia | 1982;37:658–62. | 46. Ioanndis JPA, Cappelleri JC, Lau J. Issues in comparisons between | meta-analyses and large trials. JAMA 1998;279:1089–93. | 47. Mueller MD, Bru¨hwiler H, Schu¨pfer GK, Lu¨ scher KP. Higher rate of fetal | academia after regional anesthesia for elective cesarean delivery. Obstet | Gynecol 1997;90:131–4. Vallejo MC.Should α-agonists be used as first line | management of spinal hypotension? Int J Obstet Anesth 2003; 12:243–245. | 48. Roberts SW, Leveno KJ, Sidawi JE, et al. Fetal acidemia associated with | regional anesthesia for elective cesarean delivery. Obstet Gynecol 1995; | 85:79–83. | 49. Mueller MD, Bru¨hwiler H, Schu¨pfer GK, Lu¨ scher KP. Higher rate of Fetal | acidemia after regional anesthesia for elective cesarean delivery.Obstet | Gynecol1997;90:131-134. | 50. Reynolds F, Seed PT. Anaesthesia for caesarean section and neonatal acid– base | status: a meta-analysis. Anaesthesia 2005; 60:636–653. | 51. Hartle AJ. What babies want. Anaesthesia 2005; 60:1241–1242. | 52. Clyburn P. Spinal anaesthesia for caesarean section: time for re-appraisal? | Anaesthesia 2005; 60:633–635. 7 Emmett RS, Cyna AM, Simmons SW. | 53. Techniques for preventing hypotension during spinal anaesthesia for caesarean | section. The Cochrane Database of Systematic Reviews 2002, Issue 3. Art. No.: | CD002251. DOI:10.1002/14651858.CD002251. | 54. Lewinsky RM, Riskin-Mashiah S. Autonomic imbalance in preeclampsia: | evidence for increased sympathetic tone in response to the supine-pressor test. | Obstet Gynecol 1998; 91:935–939. | 55. Chamchad D, Arkoosh VA, Horrow JC, et al. Using heart rate variability To | stratify risk of obstetric patients undergoing spinal anesthesia.Anesth Analg | 2004; 99:1818–1821.10. | 56. Hanss R, Bein B, Ledowski T, et al. Heart rate variability predicts severe | hypotension after spinal anesthesia for elective cesarean delivery | Anesthesiology2005102:1086–1093. | 57. Smiley R. Fast Fourier transforms as prophecy: predicting hypotension during | spinal anesthesia. Anesthesiology 2005; 102:1079–1080. | 58. Leduc L,Wasserstrum, Spillman T Cotton DB.Baroreflex function in normal | pregnancy. Am J Obstet Gynecol 1991; 165:886–890. | 59. Li P, Tong C, Eisenach JC. Pregnancy and ephedrine increase the release of | nitric oxide in bovine uterine arteries. Anesth Analg 1996; 82:288–293. | 60. Smiley RM, Landau R, Freedman PV, et al. Beta2-adrenoreceptor genotype | affects treatment response to hypotension after spinal anesthesia for cesarean | section. Anesthesiology 2005; 102 (Suppl 1):A19. | 61. James FM III, Greiss FCJ, Kemp RA. An evaluation of vasopressor therapy for | maternal hypotension during spinal anesthesia. Anesthesiology 1970;33:25–34. | 62. Ralston DH, Shnider SM, de Lorimier AA. Effects of equipotent ephedrine, | metaraminol, mephentermine and methoxamine on uterine blood flow in the | pregnant . Anesthesiology 1974; 40:354–370. | 63. Jackson R,Reid JA,Thorburn J. Volume preloading is not essential to prevent | spinal induced hypotension at caesarean section. Br J Anaesth 1995; 75:262–265. | 64. Ngan Kee WD, Khaw KS, Lee BB, et al. Metaraminol infusion for maintenance | of arterial pressure during spinal anesthesia for cesarean delivery: the effect of a | crystalloid bolus. Anesth Analg 2001; 93:703–708. | 65. Lee A, Ngan Kee WD, Gin T. A quantitative systematic review of randomized | controlled trials of ephedrine compared with phenylephrine for the management | of hypotension during spinal anesthesia for cesarean delivery. Anesth Analg | 2002; 94:920–926. | 66. Ngan Kee WD, Lau TK, Khaw KS, Lee BB. Comparison of metaraminol and | ephedrine infusions for maintaining arterial pressure during spinal anesthesia for | elective cesarean section. Anesthesiology 2001; 95:307–313. | 67. Riley ET. Spinal anaesthesia for caesarean delivery: keep the pressure up and | don't spare the vasoconstrictors. Br J Anaesth 2004; 92:459–461. | 68. Kobayashi S, Endou M, Sakuraya F, et al. The sympathomimetic actions of | L-ephedrine and D-pseudoephedrine: direct receptor activation or norepinephrine | release? Anesth Analg 2003; 97:1239–1245. | 69. Liles JT, Dabisch PA, Hude KE, et al. Pressor responses to ephedrine are | mediated by a direct mechanism in the rat. J Pharmacol Exp Ther | 2006;316:95–105. | 70. Tong C, Eisenach JC. The vascular mechanism of ephedrine's beneficial effect | on uterine perfusion during pregnancy. Anesthesiology 1992; 76:792–798. | 71. Lee A, Ngan Kee WD, Gin T. Prophylactic ephedrine prevents hypotension | during spinal anesthesia for cesarean delivery but does not improve neonatal | outcome: a quantitative systematic review. Can J Anaesth 2002; 49:588–599. | 72. Ngan Kee WD, Khaw KS, Lee BB, et al. A dose–response study of | prophylactic intravenous ephedrine for the prevention of hypotension during | spinal anesthesia for cesarean delivery. Anesth Analg 2000; 90:1390–1395. | 73. Hughes SC, Levinson G, Rosen MA. Anesthesia for cesarean section. In: Hughes | SC, Levinson G, Rosen MA, editors. Anesthesia for obstetrics. Philadelphia: | Lippincott Williams and Wilkins; 2002. pp. 201–236. | 74. Dyer RA, Rout CC, Kruger AM, et al. Prevention and treatment of | cardiovascular instability during spinal anaesthesia for caesarean section. S Afr | Med J 2004;94:367–372. | 75. Persky AM, Berry NS, Pollack GM, Brouwer KL. Modelling the cardiovascular | effects of ephedrine. Br J Clin Pharmacol 2004;57:552–562. | 76. Kluger MT. Ephedrine may predispose to arrhythmias in obstetric anaesthesia. | Anaesth Intensive Care 2000; 28:336. 31 Cooper DW, | 77. Carpenter M,Mowbray P, et al.Fetal and maternal effects of phenylephrine and | ephedrine during spinal anesthesia for cesarean delivery.Anesthesiology 2002; | 97:1582–1590. | 78. Lee A, Ngan Kee WD, Gin T. Dose–response meta-analysis of prophylactic | intravenous ephedrine for the prevention of hypotension during spinal anesthesia | for elective cesarean delivery. Anesth Analg 2004;98:483–490. | 79. Ngan Kee WD, Lee A. Multivariate analysis of factors associated with umbilical | arterial pH and standard base excess after caesarean section under spinal | anaesthesia.

Volume : 5 | Issue : 2 | Feb 2015 | ISSN - 2249-555X

Anaesthesia 2003; 58:125–130. | 80. Shekelle PG,Hardy ML,Morton SC, et al. Efficacy and safety of ephedra and | ephedrine for weight loss and athletic performance: a meta-analysis.JAMA 2003; | 289:1537–1545. | 81. Magkos F, Kavouras SA. Caffeine and ephedrine: physiological, metabolic and | performance-enhancing effects. Sports Med 2004; 34:871–889. | 82. Bukowiecki L, Jahjah L, Follea N. Ephedrine, a potential slimming drug, | directly stimulates thermogenesis in brown adipocytes via beta-adrenoreceptors. | Int J Obes 1982; 6:343–350. | 83. Liu YL, Toubro S, Astrup A, Stock MJ. Contribution of beta 3-adrenoreceptor | activation to ephedrine-induced thermogenesis in humans. Int J Obes Relat | Metab Disord 1995;19: 678–685. | 84. Shannon JR, Gottesdiener K, Jordan J, et al. Acute effect of ephedrine on 24 h | energy balance. Clin Sci (Lond) 1999; 96:483–491. | 85. LaPorta RF, Arthur GR, Datta S. Phenylephrine in treating maternal hypotension | caused by spinal anaesthesia for caesarean delivery: effects on neonatal | catecholamine concentrations, acid base status and Apgar scores. Acta | Anaesthesiol Scand 1995; 39:901–905. | 86. Kangas-Saarela T, Hollmen AI, Tolonen U, et al. Does ephedrine influence | newborn neurobehavioural responses & spectral EEG when used to prevent | maternal hypotension during caesarean section? Acta Anaesthesiol Scand 1990; | 34:8–16. | 87. Wright RG, Shnider SM, Levinson G, et al. The effect of maternal administration | of ephedrine on fetal heart rate and variability. Obstet Gynecol 1981;57:734–738. | 88. Gournay VA, Roman C, Rudolph AM. Effect of beta-adrenergic stimulation on | oxygen metabolism in the fetal lamb. Ped Res 1999; 45:432–436. | 89. Eisler G, Hjertberg R, Lagercrantz H. Randomised controlled trial of effect of | terbutaline before elective caesarean section on postnatal respiration and glucose | homeostasis. Arch Dis Child Fetal Neonatal Ed 1999;80:F88–F92. | 90. Wilkening RB, Meschia G. Current topic: comparative physiology of placental | oxygen transport. Placenta 1992; 13:1–15. | 91. Faber JJ. Review of flow limited transfer in the placenta. Int J Obstet Anesth | 1995;4: 230–237. 46 Wilkening RB, Meschia G. Fetal oxygen uptake, | oxygenation and acid - base balance as a function of uterine blood flow. Am J | Physiol 1983; 244:H749–H755. | 92. Erkinaro T, Makikallio K, Kavasmaa T, et al. Effects of ephedrine and | phenylephrine on uterine and placental circulations and fetal outcome following | fetal hypoxaemia and epidural-induced hypotension in a sheep model. Br J | Anaesth 2004; 93:825–832. | 93. Bythell VE, Mowbray P, Cooper DW. Phenylephrine in obstetric regional | anaesthesia.Anaesthesia 2003; 58:288–289. | 94. Strumper D,Gogarten W,Durieux ME, et al.Effects of cafedrine/theophylline | etilefrine and ephedrine on uterine blood flow during epidural-induced | hypotension in pregnant sheep. Fetal Diagn Ther 2005; 20:377–382. | 95. Wollman SB, Marx GF: Acute hydration for prevention of hypotension spinal | anesthesia in parturients. ANESTHESIOLOGY 1968; 29:374–80. | 96. Kang YG, Abouleish E, Caritis S: Prophylactic intravenous ephedrine infusion | during spinal anesthesia for cesarean section. Anesth Analg 1982; 61:839–42. | 97. Emmett RS, Cyna AM, Simmons SW: Techniques for preventing hypotension | during spinal anaesthesia for caesarean section. The Cochrane Database of | Systematic Reviews 2002; Issue 3, Art. No. CD00225.1. | 98. Ngan Kee WD, Khaw KS, Ng FF, Lee BB: Prophylactic phenylephrine infusion | for the prevention of hypotension during spinal anesthesia for cesarean delivery. | Anesth Analg 2004; 98:815–21. | 99. Ngan Kee WD, Khaw KS, Ng FF: Comparison of phenylephrine infusion | regimens for maintaining maternal blood pressure during spinal anaesthesia for | caesarean section. Br J Anaesthesia 2004; 92:469–74. | 100. Jackson R,Reid JA,Thorburn J:Volume preloading is not essential to prevent | spinal- induced hypotension at caesarean section. Br J Anaesth 1995;75:262–5. | 101. Husaini SW, Russell IF: Volume preload:Lack of effect in the prevention of | spinal-induced hypotension at caesarean section. Int J Obstet Anesth 1998;7:76–81. | 102. Ueyama H, He YL, Tanigami H, Mashimo T, Yoshiya I: Effects of crystalloid | and colloid preload on blood volume in the parturient undergoing spinal | anesthesia for elective cesarean section. ANESTHESIOLOGY 1999; 91:1571–6. | 103. Dyer RA, Farina Z, Joubert IA, Du Toit P, Meyer M, Torr G, Wells K, James | MFM:Crystalloid preload versus rapid crystalloid administration after induction | of spinal anaesthesia (coload) for elective caesarean section. Anaesth Intensive | Care 2004; 32:351–7. | 104. Mercier FJ, Roger-Christoph S, des Mesnard-Smaja V, Westerman M, Foiret | C, Fischler M, Benhamou D: Crystalloid pre-loading vs.post-loading for the | prevention of hypotension with spinal anesthesia for cesarean delivery | (abstract).ANESTHESIOLOGY 2004; 100:A18. | 105. Ngan Kee WD, Khaw KS, Lee BB, Lau TK, Gin T: A dose-response study of | prophylactic intravenous ephedrine for the prevention of hypotension during | spinal anesthesia for cesarean delivery. Anesth Analg 2000; 90:1390–5. | 106. Mercier FJ, Riley ET, Frederickson WL, Roger-Christoph S, Benhamou D, | Cohen SE: Phenylephrine added to prophylactic ephedrine infusion during | spinal anesthesia for elective cesarean section. ANESTHESIOLOGY 2001; | 95:668–74. | 107. Cooper DW, Carpenter M, Mowbray P, Desira WR, Ryall DM, Kokri MS: Fetal | and maternal effects of phenylephrine and ephedrine during spinal anesthesia for | cesarean delivery. ANESTHESIOLOGY 2002; 97:1582–90. | 108. James III FM, Greiss Jr FC, Kemp RA: An evaluation of vasopressor therapy | for maternal hypotension during spinal anesthesia.ANESTHESIOLOGY 1970; | 33: 25–34. | 109. Ralston DH, Shnider SM, deLorimier AA :Effects of equipotent ephedrine | metaraminol,mephentermine, and methoxamine on uterine blood flow in the | pregnant ewe. ANESTHESIOLOGY 1974; 40:354–70. | 110. Riley ET, Cohen SE, Rubenstein AJ, Flanagan B: Prevention of Hypotension | after spinal anesthesia for cesarean section: Six percent hetastarch versus | lactated Ringer's solution. Anesth Analg 1995; 81:838–42. | 111. Ngan Kee WD, Khaw KS, Lee BB, Ng FF, Wong MMS:A randomized | controlled study of colloid preload before spinal anaesthesia for caesarean | section.Br J Anaesth 2001; 87:772–4. | 112. Mojica JL, Melendez HJ, Bautista LE : The timing of intravenous Crystalloid | administration and incidence of cardiovascular side effects during spinal | anesthesia: The results from a randomized controlled trial.Anesth Analg | 2002;94:432–7. | 113. Alahuhta S, Ra¨sa¨nen J, Jouppila P, Jouppila R, Hollme´n AI: Ephedrine And | phenylephrine for avoiding maternal hypotension due to spinal anaesthesia for | caesarean section: Effects on uteroplacental and fetal haemodynamics. Int J | Obstet Anesth 1992;1:129–34. | 114. Hall PA, Bennett A, Wilkes MP, Lewis M: Spinal anaesthesia for Caesarean | section: Comparison of infusions of phenylephrine and ephedrine. Br J Anaesth | 1994; 73:471–4 | 115. Burns SM, Cowan CM, Wilkes RG. Prevention and management of | hypotension during spinal anaesthesia for elective caesarean section: a survey | of practice. Anaesthesia 2001; 56:794-798. | 116. Loughrey JPR, Walsh E, Gardiner J. Prophylactic intravenous bolus ephedrine | for elective caesarean section under spinal anaesthesia. Fur J Anaesthesiol 2002; | 19:63-68. | 117. Vercauteren MP, Coppejans HC, Hoffmann VH, Mertens E, Adriaensen | HA.Prevention of hypotension by a single 5-mg dose of ephedrine during | small-dose spinal anesthesia in prehydrated cesarean delivery patients. Anesth | Analg 2000; 90:324-327. | 118. Thomas DG, Robson SC, Redfern N, Hughes D, Boys RJ. Randomized trial of | bolus phenylephrine or ephedrine for maintenance of arterial pressure during | | 119. Lauckner W, Schwarz R, Retzke U. Suitability of mephentermine for the | management of arterial hypotension in pregnancy. Zentralblatt fur Gynakologie | 1978; 100:217-221. |