Spinal hypotension during caesarean section: prevention, treatment and impact on outcome

RA Dyer

SGARK 2017

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73/121 (79%) of deaths were associated with spinal anaesthesia
Spinal hypotension: Contributors and Management

- Prediction
- Bupivacaine dose
- Body mass index
- Aortocaval compression
- Arteriolar dilatation
- Fluids
- Vasopressors
  - Elective
  - Fetal compromise
Holter heart rate monitoring before spinal anaesthesia
Low/high frequency power ratio of heart rate variability
This predicted hypotension (P=.046, OR 1.48)
Optimal cut-point estimation value of 2.0
Spinal bupivacaine dose

Efficacy of low-dose bupivacaine in spinal anaesthesia for Caesarean delivery: systematic review and meta-analysis

C. Arzola¹* and P. M. Wieczorek²

< 8 mg plus opiate: 3.8 x increased requirement for analgesic supplementation
2 groups of 25 patients, <32 and >40 kg/m²
Temperature block 2 dermatomes higher at 25 minutes in obese patients
No cervical dermatomes blocked
No difference in phenylephrine requirement
20 minutes longer for block regression
• No difference in pH or base deficit
• More phenylephrine required in supine group
• Lower cardiac output if no tilt employed
• 7% had 20% decrease in cardiac output if <15 degrees’ tilt
Phenylephrine Infusion

Driving a Wedge in Our Practice of Left Uterine Displacement?

Michaela K. Farber, M.D., Brian T. Bateman, M.D., M.Sc.

The avoidance of maternal hypotension during spinal anesthesia for cesarean delivery is of paramount importance to maintain placental blood flow before delivery and to avoid maternal nausea, vomiting, and dizziness. In this issue of *Anesthesiology*, Lee et al.\(^1\) demonstrate that maintaining maternal systolic blood pressure with phenylephrine infusion prevents neonatal acid-base impairment in healthy women undergoing cesarean delivery under spinal anesthesia, whether the mother is positioned supine or in a traditional 15° left lateral tilt to prevent aortocaval compression.

Maternal hypotension after spinal anesthesia during cesarean delivery in the absence of prophylactic therapy is a predictable event, reported as high as 95% in healthy women.\(^2\) This hypotension can be a result of the neurophysiologic two approaches report that they are equally effective in achieving some degree of pelvic tilt,\(^3\) although the actual angle achieved is widely variable and often overestimated.\(^4\) Investigation of how the degree of tilt impacts hemodynamics demonstrates that hypotension from aortocaval compression is progressively eliminated by moving from full supine to full lateral position, albeit with significant interindividual variability in both the susceptibility to hypotension and to impact of the tilting maneuvers.\(^5\)

The study by Lee et al.\(^1\) calls into question whether the routine practice of left uterine displacement is necessary. The investigators point out that the 15° left lateral tilt recommended to relieve aortocaval compression is rarely achieved in routine practice. Further, they note that, in contrast to the 1970s, when the practice of uterine displacement was developed, vasoressors are now...
So how much does the venous circulation contribute to spinal hypotension?

- Rapid infusion of crystalloid preload relatively unsuccessful in preventing hypotension
  
  Rout, Anesthesiology 1999

- Crystalloid or colloid coload are better, but hypotension persists..
  
  Dyer, Anaes Intens Care 2004; Mercier, Curr Op Anaesthesiol 2012

- So, therapies based on the concept of caval compression and consequent decreased venous return, do not prevent hypotension after spinal anaesthesia
Leg wrapping reduced hypotension compared with no intervention, by counteracting early modest spinal anaesthesia-induced venodilatation
New focus

• The arterial circulation – systemic vascular resistance
  – Healthy women
  – Preeclampsia
• The physiological effects of vasopressors
Haemodynamic effects of obstetric spinal anaesthesia in healthy women

When MAP decreases by 20%:

– Systemic vascular resistance ↓35%
– Heart rate ↑12%
– Stroke volume ↑9%
– Cardiac output ↑22%

Dyer, Anesthesiology 2009
Phenylephrine infusions

Anesth Analg 2005; 100:744-50

Prevention of Hypotension during Spinal Anesthesia for Cesarean Delivery

An Effective Technique Using Combination Phenylephrine Infusion and Crystalloid Cophydration

The Dose-Dependent Effects of Phenylephrine for Elective Cesarean Delivery Under Spinal Anesthesia

Adrienne Stewart, FRCA,* Roshan Fernando, FRCA,* Sarah McDonald, FRCA,† Rachel Hignett, FRCA,‡ Tanya Jones, FRCA,§ and Malachy Columb, FRCA||

Overall recommendation: 25-50 µg/minute
Ephedrine vs Phenylephrine:

• Umbilical arterial pH 7.25 vs 7.34
• Base deficit - 4.8 vs -1.9 mmol/L
• Lactate 4.2 vs 2.2 mmol/L
Vasopressors in Preeclampsia

Ephedrine 15 mg

Phenylephrine 50 µg

Dyer et al, Anaesthesia in press
A randomised comparison of bolus phenylephrine and ephedrine for the management of spinal hypotension in patients with severe preeclampsia and fetal compromise

- Ephedrine 7.5-15 mg vs Phenylephrine 50-100 µg
- 2 groups of 32
- Primary outcome umbilical arterial base deficit
  - No differences (-4.9 vs -6.0 mmol.l⁻¹)
- UA pH and lactate levels also similar
  - (7.25 vs 7.22), and 3.41 vs 3.28 mmol.l⁻¹)
- No differences in numbers of neonates with
  - 1 minute Apgar scores <7 (10/32 [31%] vs 12/32 [38%], or
  - pH <7.2 (6/31 [19%] vs 8/29 [28%])
- Conclusion: in preeclampsia with fetal compromise, fetal acid base status is independent of the choice of vasopressor

Effects of phenylephrine on cardiac output and venous return depend on the position of the heart on the Frank-Starling relationship

Maxime Cannesson,1 Zhongping Jian,2 Guo Chen,1,3 Trung Q. Vu,1 and Feras Hatib2

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Submitted 26 January 2012; accepted in final form 1 May 2012
Randomized Double-blinded Comparison of Norepinephrine and Phenylephrine for Maintenance of Blood Pressure during Spinal Anesthesia for Cesarean Delivery


Phenylephrine 100 μg/ml vs Noradrenaline 5 μg/ml

Table: Analysis of area under the curve for serial haemodynamic changes (units are value*time).

<table>
<thead>
<tr>
<th></th>
<th>PHE</th>
<th>NOR</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic blood pressure</td>
<td>1532±67</td>
<td>1494±67</td>
<td>0.005</td>
</tr>
<tr>
<td>Heart rate</td>
<td>1343±130</td>
<td>1443±185</td>
<td>0.002</td>
</tr>
<tr>
<td>Cardiac output</td>
<td>1497±176</td>
<td>1639±189</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Stroke volume</td>
<td>1638±188</td>
<td>1648±156</td>
<td>0.8</td>
</tr>
<tr>
<td>Systemic vascular resistance</td>
<td>1552±244</td>
<td>1374±158</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
A Random-allocation Graded Dose–Response Study of Norepinephrine and Phenylephrine for Treating Hypotension during Spinal Anesthesia for Cesarean Delivery


- Bolus norepinephrine 4-12 µg vs phenylephrine 60-200 µg tested
- Norepinephrine 8 µg equivalent to phenylephrine 100 µg
Norepinephrine for Spinal Hypotension during Cesarean Delivery

Another Paradigm Shift?

Brendan Carvalho, M.B.B.Ch., F.R.C.A., Robert A. Dyer, F.C.A.(SA), Ph.D.

Anesthesiology 2015; 122:728-30

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EDITORIAL

More perfect?

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Sending a man to do a boy’s job?
Increased heart rate and cardiac output

Increased incidence of hypertension

Less phenylephrine

*Does not make physiological sense*
Reflex bradycardia

Stimulus
- Pain, emotion
- Carotid sinus sensitivity

Afferent pathway
- Medullary vasomotor centre
- Higher centres
- Parasympathetic

Efferent response
- Bradycardia
- Pancreatic polypeptide
- Sympathetic
- Norepinephrine vasodilation in resistance vessels
- Epinephrine-vasodilation in skeletal muscles

Decreased venous return
- Intra-coronary injections
- Inferior myocardial infarction
- Micturition
- Unmyelinated 'c' fibres. Respond to chemical and mechanical stimuli. Enhanced activation by β₂ receptor stimulation.

Other viscera e.g. bladder

Kinsella, Br J Anaesth 2001
ORIGINIAL ARTICLE

Effects of prophylactic ondansetron on spinal anesthesia-induced hypotension: a meta-analysis

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bCollege of Arts and Sciences, Vanderbilt University, Nashville, TN, USA

- Less hypotension, bradycardia
- Lower vasopressor requirements
- Less nausea and vomiting
Responses to spinal anaesthesia – pattern recognition

1 Hypotension, heart rate increased
   • Decreased systemic vascular resistance, some venodilatation

2 Hypotension, bradycardia
   – ? Preload reduction, reflex phenomenon
     Bezold-Jarisch, or Inverse Bainbridge

3 Persistent severe hypotension
   • Undiagnosed hypovolaemia
   • Undiagnosed cardiac pathology
     - Peripartum cardiomyopathy
     - Valvular heart disease
     - Rarely preeclampsia

4 High motor block with cardiorespiratory collapse
High motor block with cardio-respiratory collapse

The management of high spinal anaesthesia in obstetrics: suggested clinical guideline in the South African context

A South African Society of Anaesthesiologists guideline, developed by the Obstetric Anaesthesia Special Interest Society

G van Rensburg, D van Dyk, D Bishop, JL Swanevelder, Z Farina, AR Reed, RA Dyer

(under the auspices of the Obstetric Anaesthesia Special Interest Society)
Key principles – high spinal anaesthesia

• Discussion and simulation
• Always be prepared
  – Equipment prepared, readily available
  – Drugs prepared, readily available
• Early recognition, call for help
• Respiratory support immediately after vasopressor
• Run adrenaline by infusion immediately after tracheal intubation if cardiac output not restored
• Avoid propofol and thiopentone
• Continue to monitor for haemodynamic instability and respiratory recovery
Randomized comparison of closed-loop feedback computer-controlled with manual-controlled infusion of phenylephrine for maintaining arterial pressure during spinal anaesthesia for Caesarean delivery†

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Phenylephrine Infusions for Maintaining Blood Pressure During Spinal Anesthesia for Cesarean Delivery: Finding the Shoe That Fits

Warwick D. Ngan Kee, BHB, MBChB, MD, FANZCA, FHKCA, FHKAM
Simple prophylactic phenylephrine infusions may be the most appropriate in limited resource environments…
Best practice 2017

• Healthy women and preeclampsia
  – Phenylephrine: bolus or infusion (fluid coload)
    • Better reverses haemodynamic changes of SA
    • Less nausea and vomiting
  – Large doses of ephedrine cause fetal acidosis

• Tight bp control/prophylactic vasopressor
  – Bolus 50-100 µg phenylephrine
  – Continuous infusion @ 25-50 µg/min
  – Target the baseline heart rate
  – Tightest control: initial bolus then titrated infusion
Maternal Outcomes

• **Comfort**
  – Nausea and vomiting (Ngan Kee 80, 90, 100% SBP)

• **Safety**
  – Patient selection
  – Cardiac arrest: reflex/high spinal anaesthesia
  – Vasopressor prophylaxis
  – Pattern recognition
  – Appropriate intervention – context
Neonatal outcome

• Surrogate outcomes
  – Fetal acidosis
  – >2 minutes’ hypotension – oxypurines and peroxides – ischaemia/reperfusion

• Neurological outcome
  – Sustained decrease >60% in uterine blood flow for 10 minutes causes bradycardia and acidaemia
  – >4 minutes hypotension – neurobehavioural changes at 4-7 days

Ngan Kee 2009, Okudaira 2005, Hollmen 1978
Audit and research

- Confidential Enquiry into Maternal Deaths (SA)
- Obstetric Anaesthesia Special Interest Group (OASIS)
- South African Perioperative Research Outcomes Group (SAPORG)
- African Surgical Outcomes Study (ASOS – Lancet)
  - Obstetrics Case Report Form
Guidelines

International consensus statement on the management of hypotension with vaspressors during caesarean section under spinal anaesthesia

S. M. Kinsella,1 B. Carvalho,2 R. A. Dyer,3 R. Fernando,4 N. McDonnell,5 F. J. Mercier,6 A. Palanisamy,7 A. T. H. Sia,8 M. Van de Velde9,10 and A. Vercueil11
Thank you!