HYPOTENSION DURING REGIONAL ANAESTHESIA FOR
CAESAREAN BIRTH

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Hypotension may occur as a complication of epidural or spinal regional block for
labour analgesia and anaesthesia for caesarean section. It is especially
common during caesarean section when a relatively high cephalad block to the
level of T4 is normally required (Russell 1995) which induces extensive sympathetic
block with decreased systemic vascular resistance and venous return. The onset
and degree of hypotension may be particularly marked during spinal
anaesthesia (Ng et al 2004, Level I). Different definitions of hypotension have
been used. Most commonly, these have been based on changes in systolic
arterial pressure (SAP) with mean arterial pressure (MAP) used less frequently
(Adsumelli et al 2003, Level II). Criteria have been based on both absolute
changes (e.g., a decrease in SAP to < 80-100 mmHg) and relative changes (e.g.
a decrease in SAP by 10-30% below baseline) with no clear consensus on the
best measure (Cyna et al 2006, Level I). The incidence of hypotension during
spinal anaesthesia for caesarean section has been reported to be 80-90% or
greater, depending on the definition used (Cyna et al 2006, Level I). However,
the incidence is smaller in labouring patients which may be related to the effects
of pain and autotransfusion (Clarke et al 1976, Level III-2).

Untreated hypotension may have important clinical sequelae. For the mother,
hypotension is especially associated with nausea and vomiting (Balki & Carvalho
2005) and in more severe cases there may be risk of decreased consciousness,
pulmonary aspiration, respiratory depression and cardiac arrest. Although animal
studies have shown that there is a margin of safety that provides some
protection to the fetus from mild transient decreases in uteroplacental perfusion
(Wilkening & Meschia 1983, Level III-3), marked or prolonged decreases in the
human fetus are likely to be associated with fetal asphyxia and/or acidosis
(Skillman et al 1985, Level II; Datta et al 1982, Level III-2). However, the degree
and duration of hypotension that is likely to be harmful to the fetus in humans is undetermined.

Because hypotension may be associated with both maternal and fetal/neonatal morbidity, many different methods have been investigated alone and in combination for both its prevention (Cyna et al 2006, Level I) and treatment. Although prevention and treatment of hypotension are different endpoints and may be studied individually, the distinction is not clear in all studies and they are considered together in this review.

1. PATIENT POSITIONING AND PHYSICAL METHODS

1.1 Uterine displacement

In order to decrease the effects of aortocaval compression, obstetric patients who have a functional spinal or epidural block should not be maintained in the supine position. The cardiovascular effects of aortocaval compression are least when the patient is in the full lateral position (Rees et al 2002, Level II) but when this is not practical, left uterine displacement should be achieved using a wedge or by tilting the operating table to the left. Although the optimal amount of tilt is undetermined and may vary among patients, the common recommendation taking into account surgical needs and patient comfort is to use 12-15 degrees (Kinsella 2003). However, if not actually measured, the actual degree of tilt applied by anaesthetists is often overestimated (Jones et al 2003).

1.2 Leg elevation and compression

Leg elevation alone has not been shown to reduce the incidence of hypotension (Rout et al 1993, Level II). However, leg elevation combined with leg wrapping/compression or wrapping/compression alone may reduce the incidence of hypotension (Cyna et al 2006, Level I; Rout et al 1993, Level II).

2. INTRAVENOUS FLUIDS

A bolus of intravenous fluid (“prehydration” or “preload”) is commonly administered immediately prior to the administration of neuraxial anaesthesia. However, studies investigating the efficacy of prehydration for preventing hypotension have had conflicting results, partly because of differences in anaesthetic technique and the types and quantities of fluids. For epidural analgesia for labour analgesia, intravenous infusion of one litre of lactated Ringer’s solution was shown to decrease the incidence of both hypotension and fetal heart-rate abnormalities when a high concentration of bupivacaine (0.375%) was used. This benefit is not seen with more recent low-dose techniques, probably because the risk of hypotension is smaller (Hofmeyr et al 2004, Level I). The incidence of hypotension was not changed by prehydration with crystalloid prehydration at volumes of 7 mL/kg (Kinsella et al 2000, Level II) or one litre (Kubli et al 2003, Level II).
For spinal anaesthesia, the results of studies in animals and early clinical studies supported the use of crystalloid prehydration for decreasing the incidence of hypotension and reducing the need for vasopressors. However, more recent studies have shown small or no effect on the incidence of hypotension using volumes of 20 mL/kg (Rout et al 1993) and one litre (Husaini & Russell 1998, Level II; Jackson et al 1995, Level II). In contrast, studies have consistently shown that prehydration using colloid solutions in volumes of 500-1000 mL and 15 mL/kg are more effective than crystalloid (Dahlgren et al 2005, Level II; French et al 2000, Level II; Riley et al 1995, Level II; Siddik et al 2000, Level II) and more effective than no prehydration (Ngan Kee et al 2001a, Level II). However, the greater efficacy of colloids has to be balanced against greater expense and greater risk of adverse effects such as allergies (Cyna et al 2006, Level I).

Timing of intravenous fluid administration has also been investigated. Rapid crystalloid infusion started immediately after spinal injection (“coload” or “cohydration”) was shown to reduce hypotension and vasopressor requirement compared with the same volume given before induction (Dyer et al 2004, Level II). However, similar work using a colloid solution showed that efficacy was similar between the prehydration and cohydration groups (Nishikawa et al 2007, Level II).

3. MODIFICATIONS OF REGIONAL TECHNIQUE

The risk of hypotension may be reduced by decreasing the dose of local anaesthetic and limiting the extent of cephalic spread and sympathetic block (Ben-David et al 2000, Level II; Van de Velde et al 2006, Level II). Reducing local anaesthetic dose may be facilitated by addition of a lipophilic opioid (e.g. fentanyl 10-25 µg) (Ben-David et al 2000, Level II). In addition, the use of the combined spinal-epidural (CSE) technique allows small intrathecal doses to be used with the reassurance that the block can be supplemented if inadequate (Thorén et al 1994). A further CSE method is to make use of an epidural injection coincident with the spinal anaesthetic to extend the spinal effect through compression of the dura; this is referred to as epidural volume extension (EVE). In this technique, an epidural bolus of 10 ml or more of normal saline or local anaesthetic solution is administered within 5 to 10 minutes of the spinal injection. The use of lower doses of local anaesthetic with any of these techniques may not only reduce the incidence of hypotension and the associated need for other interventions in healthy women but may create the opportunity to use a regional technique in those situations in which this would be relatively contraindicated, such as severe heart disease (Hamlyn 2005, Level IV).

4. VASOPRESSORS

Because of the poor efficacy of non-pharmacological techniques to effectively manage hypotension, a vasopressor is usually required during spinal anaesthesia for caesarean section. However, there is controversy regarding both the choice of vasopressor and the optimal method of administration.
In choosing an appropriate vasopressor in obstetrics, a number of different factors need to be considered. These include efficacy for maintaining blood pressure, non-cardiovascular maternal effects, ease of use, direct and indirect fetal effects, cost and availability. Although a number of different drugs have been described, in Australia and New Zealand the choice is mainly limited to ephedrine, phenylephrine and metaraminol.

4.1 Ephedrine

Ephedrine is a long-established and readily available drug that is familiar to most anaesthetists. After decades of use in obstetrics, there are few reports of adverse clinical outcomes for mother or baby with ephedrine. Ephedrine is an indirect-acting non-specific adrenergic agonist and increases blood pressure mainly by increasing cardiac output (beta effect) with a smaller contribution from vasoconstriction (alpha effect). Use of ephedrine in obstetric patients is supported by animal studies which showed that uteroplacental blood flow is better maintained when ephedrine was used to raise maternal blood pressure compared with alpha agonists (Ralston et al 1974, Level III-2). Ephedrine may be given by intermittent bolus (5-10 mg) or infusion. Use of prophylactic intravenous boluses have limited efficacy unless large doses are used (Ngan Kee et al 2000, Level II). Prophylactic intramuscular ephedrine has been shown to have varying efficacy and reactive hypertension occur, so this technique is not recommended (Rout et al 1992).

Disadvantages of ephedrine include a slow onset and relatively long duration which may make accurate titration of blood pressure difficult (Ngan Kee et al 2001b, Level II); however, this may be an advantage when ephedrine is given prophylactically before or during the establishment of spinal anaesthesia for caesarean section. The optimal timing of vasopressor administration still requires further investigation (Cyna et al 2006, Level I). Ephedrine has limited efficacy to maintain blood pressure, and to prevent maternal symptoms, large doses may be required (Ngan Kee et al 2000, Level II). Phenylephrine may need to be added when ephedrine is ineffective or after a large dose has been given. Increased heart rate and contractility may increase myocardial oxygen demand and there has been a reported case of palpitations, atrial and ventricular ectopic beats and tachyarrhythmias in the context of pre-existing anxiety (Kluger 2000).

Recent clinical studies have shown ephedrine to be associated with a dose-related propensity to depress fetal pH and base excess (Lee et al 2002, Level I). The mechanism of this is still under investigation (Ngan Kee et al 2007b, Level II) and the clinical relevance of small changes in fetal acid-base status is unclear.

4.2 Phenylephrine

Phenylephrine is a potent direct-acting alpha agonist. It has a fast onset and short duration of action which facilitates ease of titration (Ngan Kee et al 2004). In pregnancy, because of a generalised reduction in the pressor response to
endogenous and exogenous vasoconstrictors (Weiner et al 1989), relatively large doses of phenylephrine may be required. However, fetal acidosis has not been demonstrated when phenylephrine is used liberally to maintain maternal blood pressure and prevent symptoms (Ngan Kee et al 2004). Phenylephrine can be given by intermittent IV bolus (50-100 μg) or by IV infusion (50-100 μg/min initially), titrated to effect. Prophylactic infusion of phenylephrine is effective for preventing hypotension when combined with simultaneous rapid IV fluid “cohydration” (Ngan Kee et al 2005, Level II). Maternal symptoms are reduced if infusions are titrated with the objective of maintaining blood pressure near to baseline levels (Ngan Kee et al 2004).

When phenylephrine is used, a reflex slowing of maternal heart rate is commonly observed (Thomas et al 1996) and cardiac output may decrease but the clinical significance of this is unknown. Most available data on the use of phenylephrine have been obtained from low-risk unstressed cases. However, few data are available for its use in preterm, emergency, labouring or hypertensive patients, or in cases where there is preexisting fetal compromise.

4.3 Metaraminol

Limited data is available for the use of metaraminol. Typical doses are 0.25-0.5 mg by IV bolus or 0.25-0.5 mg/min by IV infusion (Ngan Kee et al 2001b, Level II). Comparison of metaraminol with ephedrine by infusion for the treatment of hypotension has shown more accurate control of blood pressure and better fetal acid-base status with metaraminol (Ngan Kee et al 2001b, Level II).

5. COMBINATION THERAPIES

No single methods have been found to be consistently effective for preventing hypotension (Cyna et al 2006, Level I). However, combinations of therapies may be more effective. For example, use of a phenylephrine infusion with concurrent cohydration has been shown to be effective for preventing hypotension in >90% of cases (Ngan Kee et al 2005, Level II). Several studies have described combinations of phenylephrine and ephedrine together (Cooper et al 2002; Mercier et al 2001; Ngan Kee et al 2008). In theory, the positive chronotropic and inotropic effects of ephedrine may be useful to counter the reflex decreases in heart rate and cardiac output that phenylephrine may induce. However, the optimal combination ratio is unknown and there is little evidence that this approach is superior to phenylephrine alone.

6. COMPLICATED PARTURIENTS

Previously, hypotension has been considered to be more likely in patients with pre-eclampsia and multiple pregnancy, but this has been refuted in more recent studies (Aya et al 2003, Level III-2; Ngan Kee et al 2007a, Level III-3). Aortocaval compression may be exaggerated in multiple gestation pregnancy so lateral uterine displacement is particularly important. Intravenous fluids should be used with caution in preeclamptic patients because of the risk of pulmonary oedema.
In patients with heart disease, therapy should be individualised taking into account the risks of fluid overload and specific effects of different vasopressors on heart rate, contractility and systemic vascular resistance.

KEY MESSAGES

1. Hypotension is a frequent complication of neuraxial anaesthesia in obstetrics and may have detrimental effects on both mother and fetus (Level I).

2. Hypotension is especially common during caesarean section, especially during spinal and in non-labouring patients (Level I).

3. Definitions of hypotension vary but commonly used criteria include a decrease in systolic BP to < 80-100 mmHg or by 10-30% below baseline.

4. Left uterine displacement should be applied to all patients after neuraxial block (Level II).

5. Wrapping of the legs reduces the incidence of hypotension (Level II).

6. Prehydration with crystalloid solutions has poor efficacy for preventing hypotension. Colloids have greater efficacy but this must be balanced against greater cost and potential adverse effects (Level I).

7. The choice of vasopressor is controversial. Ephedrine preserves uterine blood flow but has limited efficacy and is associated with small decreases in fetal pH and base excess (Level I).

8. Phenylephrine is effective and easily titrated but may decrease maternal heart rate and cardiac output (Level II).

9. Combination of therapies, e.g. intravenous cohydration and vasopressor infusion may be more effective than single therapies for preventing hypotension (Level II).

REFERENCES


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