

Spinal anesthesia in the obstetric patient : prevention and treatment of hypotension

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Regional anesthesia is undoubtedly the most popular technique of anesthesia for cesarean section. In 2002 in the UK, 95% of elective sections and 87% of emergency operative deliveries were performed under regional anesthesia (11). Most of these regional blocks were either single shot spinals or combined spinal epidurals (CSE). VAN HOUWE *et al.* performed a survey in Flanders and reported that regional anesthesia was used in 95% of patients undergoing cesarean section (34). Spinal anesthesia alone or as part of a CSE was used in 80% of operative deliveries (34). Spinal anesthesia is popular because it is a simple technique which produces fast and highly effective anesthesia whilst avoiding general anesthesia. General anesthesia is associated with significantly more maternal morbidity and mortality (10).

However, spinal anesthesia is associated with a high incidence of maternal hypotension which can result in fetal distress and maternal discomfort. This manuscript reviews the most recent literature on the most effective strategies to prevent and manage maternal hypotension following spinal anesthesia for cesarean section.

SPINAL INDUCED HYPOTENSION : THE SCOPE OF THE PROBLEM

The pathophysiology of hypotension following spinal anesthesia is well described. Sympathetic block causes arterial and arteriolar vasodilation, resulting in hypotension. Also venodilation is present, which results in decreased cardiac preload, reduced cardiac output and maternal hypotension. In pregnancy, this is further aggravated by the effects of the gravid uterus and subsequent aortocaval compression. As a result of sympatholysis maternal bradycardia accentuates the observed hemodynamic effects.

The reported incidence of maternal hypotension is high with most trials reporting an incidence well over 50% (19, 28, 29, 31). Also the incidence is much higher than that reported following general

and epidural anaesthetic techniques (5). Hypotension causes maternal nausea and vomiting and as a result of treatment can induce iatrogenic pulmonary edema or severe maternal hypertension. Because of hypotension, patients may also fail to cooperate, complicating surgery.

Also the fetus is affected by hypotension. If hypotension is severe enough and/or prolonged enough, fetal acidosis is a distinct possibility. ROBERTS *et al.* compared general, epidural, spinal and CSE anesthesia techniques in over 1600 patients undergoing elective cesarean section in a single centre (26). Significantly more patients treated with either CSE or single shot spinal anesthesia experienced fetal umbilical artery acidosis. Mueller and co-workers published a large epidemiologic study evaluating the incidence of fetal acidosis in a Swiss population of 5806 patients undergoing elective cesarean section (17). Significantly more patients receiving spinal anesthesia experienced serious fetal acidosis (umbilical artery pH < 7.10) as compared to patients treated with either epidural or general anesthesia. In a recent meta-analysis, Reynolds and Seed confirmed that spinal anesthesia produces more neonatal acidosis as compared to epidural and general anesthesia (24).

Until some 5 to 10 years ago, obstetric anesthesia textbooks advised to preload the patient with crystalloids and maintain left lateral tilt during surgery to prevent hypotension. Ephedrine was the drug of choice to treat hypotension if it occurred. It was thought that ephedrine was safe for the fetus and would not cause fetal acidosis. However in recent years these dogmas have been challenged.

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CRYSTALLOID AND COLLOID PRELOADING

Based on animal and patient studies performed in the 1960's, crystalloid preloading was considered to be an effective and safe method to prevent spinal induced hypotension during cesarean section (9, 15, 37). When questioned, most UK anesthetists (> 87%) give crystalloid pre-loading prior to spinal anesthesia for cesarean section, usually 500-1000 ml (2). In the early 1990's, Rout and co-workers began to question the value of intravenous preloading with crystalloids (28, 29). They demonstrated that crystalloid pre-loading could only marginally reduce the incidence of hypotension. Ngan Kee and Lee performed a multivariate analysis of factors associated with hypotension and umbilical artery acidosis in a patient population which had previously participated in trials performed at their institution and noted that crystalloid pre-loading did not affect the incidence of hypotension nor the incidence of umbilical artery acidosis (21). A qualitative literature review confirmed that crystalloids do not reliably prevent spinal induced hypotension (16). More recent evidence however suggests that co-loading of crystalloids (rapid infusion whilst performing or just after induction of spinal anesthesia) offers a marginal benefit in terms of incidence and severity of hypotension, when combined with vasopressor therapy (6, 20).

The message for colloid preloading is however different. Numerous trials compared different colloid solutions with lactated Ringer's solution in the prevention of hypotension (25, 30, 32). It was consistently shown that the incidence and severity of hypotension was reduced with colloids as opposed to crystalloid infusion. This was confirmed by a systematic literature review by MORGAN *et al.* (16). These authors however pointed out that colloids are more expensive and carry a small risk of anaphylaxis.

Crystalloid preloading, to prevent spinal anesthesia induced hypotension during cesarean delivery, confers no benefit in terms of the incidence and severity of hypotension. Colloid preloading, however, does improve maternal haemodynamics.

VASOPRESSOR OF CHOICE : EPHEDRINE OR PHENYLEPHRINE

For many years ephedrine was considered the vasopressor of choice to prevent and treat spinal induced hypotension. Ephedrine was established as the vasopressor of choice because it was believed

that it had the least vasoconstrictive effects on the uteroplacental circulation (22). Despite its widespread acceptance, ephedrine has shortcomings. In recent years it has become clear that prophylactic ephedrine fails to prevent hypotension unless very high doses are given intravenously (> 30 mg) (19). Furthermore, Ngan Kee and co-workers demonstrated that ephedrine itself is associated with more neonatal acidosis, especially if high doses are administered (12, 19, 21). COOPER *et al.* suggested this was due to a fetal metabolic effect of ephedrine, which easily crosses the placenta (3).

Traditionally, phenylephrine was regarded not suitable for obstetric anesthesia because it was suspected it would cause uteroplacental vasoconstriction and fetal distress despite normalization of the blood pressure. In recent years however it has become clear that phenylephrine is the most effective and safe vasopressor to be used during spinal anesthesia for cesarean section (18). Although some issues remain controversial (what about emergency cases, preterm babies or labouring patients?) and although phenylephrine causes reflex bradycardia and decreases cardiac output, most experts now agree that "phenylephrine is the vasopressor that most closely meets the criteria for the ideal vasopressor to use in obstetric patients" (18).

LOW DOSE SPINAL ANESTHESIA

Numerous prophylactic strategies have been tested to prevent spinal induced hypotension. Very few have been shown to be partially effective: colloid fluid pre-loading, crystalloid co-loading, vasopressors and lower limb compression (7). However the incidence of hypotension can be reduced but hypotension can not be eliminated (7). Most studies use doses of spinal bupivacaine of 9-15 mg. Various authors have suggested that lowering the spinal dose to less than 7.5 mg of bupivacaine intrathecally might reduce the incidence and severity of hypotension.

Several trials have reported a low incidence of hypotension when low doses of bupivacaine were used (1, 4, 35, 36). However these trials were flawed due to the lack of a control group. LEW *et al.* did compare different doses and failed to demonstrate a beneficial effect of reducing the spinal dose (13). However, they only measured blood pressure every 2.5 minutes and may have missed differences. Furthermore, they used different anesthetic techniques in both groups. FAN *et al.* directly compared different bupivacaine doses and concluded that

lowering the spinal dose effectively improved the hemodynamic maternal profile (8).

Unfortunately, the trial by FAN *et al.* did not add opioids to the anesthetic mixture, resulting in a high incidence of inadequate anesthesia (8). The addition of opioids improves anesthetic quality without affecting hemodynamics (1, 13, 14, 35, 36). We also tested low dose bupivacaine combined with sufentanil as part of a CSE technique of anesthesia and compared it with higher bupivacaine doses (33). The incidence of hypotension was significantly reduced but the need for epidural catheter supplementation, especially when surgery extended beyond 1 hour, was significant. Small dose spinal anesthesia is therefore only feasible if epidural catheter back up is possible, as with a CSE technique. This was also demonstrated by RANASINGHE *et al.* (23). What is relevant is its high overall success-rate as compared to single shot spinal or epidural anesthesia alone (23).

To conclude it can be said that low dose spinal anesthesia with bupivacaine and sufentanil better preserves maternal hemodynamic stability, while resulting in equally efficacious anesthesia. However duration of adequate surgical block is limited, suggesting that these low doses only be used when the block can be reinforced with a catheter.

CONCLUSIONS

Spinal induced hypotension is a common problem during cesarean section associated with maternal nausea and vomiting and the risk of fetal and neonatal acidosis. Crystalloid pre-loading confers no benefit, whilst colloid pre-loading is beneficial. The vasopressor of choice, according to most contemporary experts, is phenylephrine. Lowering the intrathecal dose of bupivacaine seems to be a useful technique as well to reduce the incidence of hypotension. However no prophylactic technique can successfully eliminate hypotension. A combined approach using colloid pre-loading, vasopressors and a low dose CSE is probably the best option to provide anesthesia for cesarean section.

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