Low-dose spinal anaesthesia for Caesarean section to prevent spinal-induced hypotension

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Current Opinion in Anaesthesiology 2008, 21:259–262

Purpose of review

The present review evaluates the evidence available in the literature to see whether low-dose spinal anaesthesia for Caesarean section is effective in preventing maternal hypotension while at the same time guaranteeing effective anaesthetic conditions.

Main findings

From prospective trials, it is clear that lowering the spinal dose improves maternal haemodynamic stability. Doses of intrathecal bupivacaine between 5 and 7 mg are sufficient to provide effective anaesthesia. Complete motor block is, however, seldom achieved and adequate anaesthesia is limited in time.

Summary

Low-dose spinal anaesthesia as part of a combined spinal–epidural technique is a valuable method in improving maternal and fetal outcome during anaesthesia for operative delivery.

Keywords

Caesarean section, combined spinal–epidural anaesthesia, low-dose spinal, obstetric anaesthesia

Curr Opin Anaesthesiol 21:259–262

0952-7907

Introduction

Spinal-induced hypotension is a common problem during Caesarean delivery. It can cause serious maternal and fetal morbidity. Various strategies to prevent hypotension are only partially successful. The present review will focus on the usefulness and efficacy of low-dose spinal anaesthesia to prevent maternal hypotension while maintaining good anaesthetic conditions.

The Caesarean section rate is increasing throughout the Western world [1]. Spinal anaesthesia is the preferred anaesthetic technique for elective operative delivery and is also commonly used for unplanned Caesarean section [1]. Spinal-induced hypotension remains the most important side effect with a reported incidence between 20 and 100% [2–4]. Hypotension can cause maternal discomfort (nausea and vomiting) [2] and impaired utero-placental perfusion, resulting in fetal acidemia [5,6]. The risk of fetal acidemia depends on the severity and duration of the hypotensive episode [7].

Various strategies have been described to prevent hypotension: left uterine displacement, prophylactic intravenous (i.v.) fluid loading using both crystalloids and colloids, maternal leg wrapping and prophylactic ephedrine or phenylephrine infusions. Spinal-induced hypotension remains a common problem in patients undergoing Caesarean delivery [2,3,8–15]. A recent meta-analysis [16••] showed that although interventions such as colloids, ephedrine, phenylephrine or lower leg compression can reduce the incidence of hypotension, none has been shown to eliminate the need to treat maternal hypotension during spinal anaesthesia for Caesarean section. Furthermore, prophylactic management has been associated with side-effects: large volumes of i.v. fluids increase the risk of iatrogenic pulmonary oedema in high-risk pregnant patients, prophylactic vasopressors can cause hypertension and prophylactic ephedrine has been associated with fetal acidosis [15,17]. Apart from reflex bradycardia, phenylephrine can cause maternal arrhythmias. Lai and Jenkins [18] recently described a case of ventricular bigeminy seconds after starting a phenylephrine infusion, which reverted spontaneously to sinus rhythm when the phenylephrine infusion was stopped.

Some evidence available in the literature is present indicating that reducing the spinal dose of bupivacaine can produce effective anaesthesia with less haemodynamic side effects. The present review will put this evidence into perspective

Haemodynamic effects of low-dose spinal anaesthesia

Fan *et al.* [19] evaluated the effects of different spinal doses of bupivacaine, as part of a combined spinal–epidural (CSE) technique of anaesthesia. A CSE was

performed in 80 healthy, term parturients who underwent elective Caesarean deliveries. All patients received 1000 ml of Ringer's solution. Patients were randomized to four groups: group A received 2.5 mg hyperbaric bupivacaine intrathecally, group B 5 mg, group C 7.5 mg and group D 10 mg. An epidural catheter was then inserted into the epidural space. If after 15 min a block to pinprick to level T4 was not reached, additional epidural local anaesthetic was administered. Hypotension was defined as a systolic blood pressure (SBP) below 90 mmHg or a 30% decrease in SBP from baseline. When hypotension occurred, ephedrine was administered per 5 or 10 mg intravenously. A very little hypotension was observed in groups A and B, whereas the incidence of hypotension was 35% in group C and 50% in group D. Significantly less ephedrine was required in groups A, B and C compared with group D. The incidence of nausea and vomiting was higher in the patients treated with 7.5 and 10 mg of bupivacaine. There was also more maternal dyspnea in the group treated with 10 mg bupivacaine.

Ben-David *et al.* [20] also studied the effect of low-dose spinal anaesthesia on maternal haemodynamics. They randomized 32 patients to two study groups: in one group, isobaric bupivacaine 10 mg was intrathecally administered; in the second group, 5 mg of isobaric bupivacaine was given intrathecally combined with 25 μg of fentanyl. Hypotension was defined as a decrease of SBP below 95 mmHg or a 25% decrease from baseline. When hypotension occurred, boluses of 5 mg ephedrine were given. In all patients good-quality anaesthesia was noted, although some patients in the 5 mg group noted some discomfort at the time of delivery. Nevertheless, the only reason for complaint and not being fully satisfied with anaesthesia was nausea and vomiting which only occurred in the 10 mg group. The incidence of nausea and vomiting, the incidence of hypotension and the average dose of ephedrine, required to treat hypotension, were also much higher in the bupivacaine 10 mg group compared with 5 mg bupivacaine combined with fentanyl.

Vercauteren and coworkers [21–23] published three trials in which they evaluated the incidence of hypotension following CSE anaesthesia with 6.6 mg of hyperbaric bupivacaine and 3.3 μg sufentanil. CSE was performed with the patients sitting. All patients received 5 mg of prophylactic ephedrine, 1000 ml of Ringer's solution and 500 ml of hydroxyethyl starch solution prior to spinal anaesthesia. Hypotension was defined as an SBP less than 90 mmHg. Hypotension occurred for both studies combined in only eight out of 102 patients (8%). This is probably the lowest incidence reported by any previous author. The same group recently compared low-dose CSE anaesthesia with plain levobupivacaine, bupivacaine and ropivacaine, all three combined with sufentanil, and confirmed that low-dose CSE anaesthesia is able to preserve maternal haemodynamics in most women [24].

More recently, Choi *et al.* [25] compared single shot spinal anaesthesia, using 9 mg of hyperbaric bupivacaine with 20 μg of fentanyl, with CSE anaesthesia using 6 mg hyperbaric bupivacaine with 20 μg fentanyl intrathecally. Prophylactic Ringer's solution was given intravenously. Hypotension was defined as an SBP decrease of more than 20% from baseline or a decrease below 95 mmHg. Hypotension was treated with ephedrine. Significantly more patients in the high-dose spinal group experienced hypotension, and this resulted in a significantly higher proportion of patients in nausea and vomiting.

At our institution, we also performed a randomized comparison of patients treated with CSE using either 6.5 or 9.5 mg of hyperbaric bupivacaine combined in both groups with 2.5 μg of sufentanil [26]. Patients in the 9.5-mg group experienced more pronounced and longer hypotensive periods compared with the 6.5-mg group. The mean lowest recorded systolic pressure was higher in the 6.5-mg group (102 ± 16 vs. 88 ± 16 in the 9.5-mg group; $P < 0.05$). More patients in the 9.5-mg group experienced hypotension compared with the 6.5-mg group (68 vs. 16%, $P < 0.05$). In the 9.5-mg group 15 patients required pharmacological treatment for hypotension, compared with five in the 6.5-mg group.

Chen *et al.* [27] performed a dose–response study of spinal hyperbaric ropivacaine in 60 parturients scheduled for elective Caesarean section. The patients were randomized to four groups and received intrathecally, using a CSE technique, 10.5, 12, 13.5 or 15 mg of hyperbaric ropivacaine following a fluid load with 1000 ml of Ringer's lactate solution. The rate of hypotension was significantly correlated to the dose of ropivacaine.

Teoh *et al.* [28] evaluated the effect of ultra low dose spinal anaesthesia as part of a CSE technique for elective Caesarean deliveries. Forty-four women were randomized in a double-blinded trial to two groups. The first group received intrathecal hyperbaric bupivacaine 3.75 mg in combination with 25 μg fentanyl, 0.1 mg morphine and an epidural test dose of 3 ml lidocaine 1.5%. The second group received 9 mg of hyperbaric bupivacaine with the same adjuvants and test dose. Hypotension was defined as a systolic pressure less than 80% of baseline and was treated with boluses of 5 mg of ephedrine intravenous. The haemodynamic parameters and block profile were measured every 2.5 min until delivery of the baby and every 5 min thereafter until the end of surgery. There was a significantly low hypotension in the low-dose group with less ephedrine use and a faster motor recovery. The same authors reported four cases of Caesarean section in severe

preeclampsia using low-dose CSE anaesthesia with stable maternal haemodynamics [29].

Kaya *et al.* [30••] studied the combined effect of low-dose spinal bupivacaine with or without colloid preload or wrapping of legs to normal dose spinal bupivacaine on reduction of maternal hypotension during Caesarean section. They randomized 120 patients into four groups. The first group received 10 mg of bupivacaine intrathecally with 500 ml of Ringer's lactate. The second group received a low-dose spinal with 4 mg of bupivacaine and 25 μg of fentanyl with 500 ml of Ringer's lactate solution. The third group received the same low-dose spinal with 500 ml hydroxyethyl starch and the fourth group received low-dose spinal with colloid preloading and wrapping of the lower extremities. Hypotension was reduced from group 1 to 4 from 100 to 70, 47 and 23%, respectively. Low-dose spinal therefore reduced hypotension, and this was further reduced by colloid preloading and leg wrapping.

Recently, Ghazi and Raja [31] published a letter on their experience with low-dose CSE and concluded that the incidence of maternal hypotension and the need for vasopressors was reduced in women undergoing operative delivery.

McNaught and Stocks [32] recently published a review on the topic of low-dose spinal anaesthesia and epidural volume extension. They concluded that epidural saline can extend a spinal block. They also found that the CSE technique itself results in a higher sensory level of the block. This is explained by a change in epidural pressure when the epidural space is identified with the Tuohy needle, as negative epidural pressure is neutralized by the open connection to atmospheric pressure resulting in a reduction in dural sac volume, similar to injection of fluid. These authors concluded that a low-dose spinal anaesthesia is effective in reducing maternal haemodynamic instability.

From these trials, it is clear that hypotension occurs less frequently, is less severe and requires less pharmacological treatment when lower spinal doses are administered intrathecally as compared with higher, more generally accepted doses.

Quality of anaesthesia

Many anaesthetists would worry that lowering the spinal dose would reduce the quality of anaesthesia and increase the incidence of pain during Caesarean section [33]. Evans and Adekanye [33] raised their worries in a recent letter. Indeed, Fan *et al.* [19] and Ben-David *et al.* [20] reported more breakthrough pain with bupivacaine doses of 5 mg or less. Nevertheless, Vercauteren *et al.* [21–23] and Choi *et al.* [25], using between 6 and 7 mg of bupivacaine combined with opioids, reported excellent anaesthetic conditions. Nevertheless, these authors used a CSE technique and could give epidural top-ups if required or they could anticipate pain if surgery was unexpectedly prolonged. In their review of the literature, McNaught and Stocks [32] did conclude that the technique of using low intrathecal doses has an increased risk of intraoperative pain, shorter duration of effective anaesthesia with a slower onset.

In our trial, epidural supplementation was required in approximately 20% of patients treated with 6.5 mg bupivacaine compared with only 8% of patients treated with 9.5 mg bupivacaine [26]. If additional epidural anaesthesia was required, this only occurred when surgery was prolonged after 60 min from the start of the spinal injection. As we are using low spinal doses (5.5–6.5 mg bupivacaine with sufentanil) routinely as part of a CSE technique, we now know that if the uterus is not closed approximately 45 min after start of the CSE, epidural supplementation will be required and an epidural top-up (5–8 ml of ropivacaine 0.75% with sufentanil) is given prophylactically. We only very rarely have to supplement the initial spinal dose with epidural local anaesthetic within 1 h of the spinal injection. We also very rarely observe complete motor block. Indeed many authors [25,32] report on faster motor recovery.

Conclusion

From prospective trials, it is clear that lowering the spinal dose improves maternal haemodynamic stability. Doses of intrathecal bupivacaine between 5 and 7 mg are sufficient to provide effective anaesthesia. Nevertheless, complete motor block is seldom achieved, and adequate anaesthesia is limited in time. As a result, an epidural back-up catheter is a must. In my clinical practice, experience makes us learn that a dose between 5.5 and 6.5 mg combined with opioids provides reliable anaesthesia from start of the spinal injection for 60–70 min. If the uterus is not closed after 45 min, an epidural top-up is given to prevent breakthrough pain.

References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

- • of special interest
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Additional references related to this topic can also be found in the Current World Literature section in this issue (p. 415).

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