Randomized controlled study of colloid preload before spinal anaesthesia for Caesarean section

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We randomized women having elective Caesarean section to receive either no preload (control group, n=33) or 4% gelatin solution (Gelofusine) 15 ml kg⁻¹ (colloid group, n=35) i.v. before spinal anaesthesia. Intravenous metaraminol was titrated at 0.25–0.75 mg min⁻¹ to maintain systolic arterial pressure (SAP) in the target range 90–100% of baseline after the spinal injection. The control group required more vasopressor in the first 10 min [median 1.7 (range 0–2.9) mg vs 1.4 (0–2.8), P=0.02] at a greater maximum infusion rate [0.5 (0–0.75) vs 0.25 (0–0.5) mg min⁻¹, P=0.0005] and had a lower minimum SAP [90 (51–109) vs 101 (75–127) mm Hg, P=0.006] than the colloid group. Nausea was less frequent in the colloid group (6 vs 24%) but neonatal outcome was similar in the two groups. Colloid preload improved haemodynamic stability but did not affect neonatal outcome when arterial pressure was maintained with an infusion of metaraminol during spinal anaesthesia for Caesarean section.

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The use of intravenous fluid preload before spinal anaesthesia for Caesarean section is controversial. Crystalloid preload has minimal effect on the incidence of hypotension, vasopressor requirement and maternal and neonatal outcome.1 2 Fewer data are available on colloid preload, which has not been compared previously with a control of no preload. Because colloid solutions augment circulating volume more than crystalloids, they may be more effective in maintaining arterial pressure.3 The aim of this study was to evaluate preloading with gelatin solution 15 ml kg⁻¹ vs no preload in patients in whom we maintained arterial pressure with an infusion of metaraminol. We chose to investigate gelatin solutions because they are the most commonly used colloid in our institution and because they have a relatively short intravascular half-life that is well matched to the usual duration of surgery for Caesarean delivery.

Methods and results

After ethics committee approval and written informed consent, we recruited 70 ASA I–II women with term singleton pregnancies having spinal anaesthesia for elective Caesarean section. Patients with hypertension, pre-eclampsia, cardiovascular or cerebrovascular disease, known fetal abnormality or any contraindication to spinal anaesthesia were excluded. Ranitidine and sodium citrate were given for premedication. After arrival at the operating theatre, baseline systolic arterial pressure (SAP) and heart rate (HR) were calculated as the mean of three successive measurements with a difference of no more than 10%, taken at intervals of 1 min.

We allocated patients randomly using sequentially numbered, coded envelopes, to receive no preload (control group) or 4% succinylated gelatin solution 15 ml kg⁻¹ (Gelofusine: B. Braun Medical, St Gallen, Switzerland) i.v. over 15 min (colloid group). This volume is at the upper end of the range of volumes investigated previously.3 Preloading was supervised by a research nurse. To maintain blinding, the anaesthetists and other investigators remained outside the operating theatre during the preloading period. Patients were not blinded.

Immediately after the preloading period, spinal anaesthesia was induced with the patients in the lateral position, using 0.5% bupivacaine 2.0 ml plus fentanyl 15 µg. Patients were then turned supine with left lateral tilt and lactated Ringer’s solution was infused at 2 ml min⁻¹, controlled with

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an infusion pump. Arterial pressure was measured at 1-min intervals beginning 1 min after the spinal injection. An i.v. infusion of metaraminol 0.5 mg ml\(^{-1}\) was started after the SAP had decreased to <90\% of baseline. A bolus of metaraminol 0.5 mg was given and the infusion was titrated at 0.25–0.75 mg min\(^{-1}\) with a syringe pump to maintain SAP in the target range 90–100\% of baseline, using a protocol we have described previously.\(^2\)\(^4\) We recorded the rate of metaraminol infusion each minute and the cumulative consumption of metaraminol 5 and 10 min after spinal injection and at the time of uterine incision.

Ten minutes after spinal injection, the block level was checked and preparation for surgery was started. Oxygen 5 litres min\(^{-1}\) was given by face mask until delivery. Times of skin incision, uterine incision and delivery were recorded with a stopwatch. Nausea and vomiting not associated with hypotension were treated with metoclopramide 10 mg i.v. After delivery, oxytocin 10 IU was given i.v. and the study was terminated. Apgar scores were assessed at 1 and 5 min by the attending paediatrician and arterial and venous blood samples were taken from a double-clamped segment of umbilical cord for immediate blood gas analysis.

Prospective power analysis based on data from previous studies in our department showed that 33 patients per group would give 80\% power with \(\alpha=0.05\) to detect a 20\% difference between groups in the total amount of metaraminol required. To allow for potential dropouts, we recruited 35 patients per group. Data are presented as median (range) and were analysed using Mann–Whitney and Fisher’s exact tests. Serial haemodynamic measurements up to the time of the earliest uterine incision were analysed by repeated measures analysis of variance.\(^5\) \(P<0.05\) was considered significant.

Two patients in the control group were excluded because of protocol violations. Except for one patient in the colloid group, all patients received metaraminol. Patient characteristics, block height and surgical times were similar between groups.

Haemodynamic changes and metaraminol infusion rates are shown in Fig. 1. There was a significant change in SAP over time \((P<0.0001)\); this did not differ between groups \((P=0.26)\), although the pattern of change was different between groups \((P=0.03)\). The minimum recorded SAP was lower in the control group than in the colloid group \(90\) (51–109) vs 101 (75–127) mmHg, 95\% confidence interval (CI) of the difference 3–16 mmHg, \(P=0.006\)). Twenty-one patients (64\%) in the control group had a decrease in SAP of greater than 20\% compared with 11 patients (31\%) in the colloid group \((P=0.01)\). Heart rate was lower in the control group than in the colloid group \((P=0.01)\), with no significant group \(\times\) time interaction \((P=0.8)\). Serial changes in metaraminol consumption were similar in the two groups; however, compared with the colloid group, the control group had a greater cumulative metaraminol consumption at 5 min \(1.1\) (0–1.9) mg \(vs\) 0.8 (0–1.8) mg; 95\% CI of the difference 0–0.4 mg, \(P=0.01\) and 10 min \(1.7\) (0–2.9) \(vs\) 1.4 (0–2.8) mg; 95\% CI of the difference 0–1.7 mg, \(P=0.02\) and required a greater maximum infusion rate \(0.5\) (0.25–0.75) \(vs\) 0.25 (0–0.5) mg min\(^{-1}\); 95\% CI of the difference 0–0.25 mg min\(^{-1}\), \(P=0.0005\)). The total dose of metaraminol at uterine incision was similar between groups \(3.1\) (0–4.8) vs 3.5 (0.9–6.3) mg; 95\% CI of the difference –0.1 to 1.1 mg, \(P=0.08\).

Eight patients (24\%) in the control group had nausea or vomiting \(vs\) two patients (6\%) in the colloid group \((P=0.04)\). Apgar scores were similar between groups, with all scores \(\geq 7\). Umbilical arterial pH was similar in the control group [median 7.31 (range 7.23–7.39)] and the colloid group [7.30

![Fig 1 Changes in systolic arterial pressure (SAP), heart rate and metaraminol consumption against time. Values are mean (SD). Dotted lines show approximate target range for SAP. Serial changes in SAP were similar in the two groups, although the pattern of change was different between groups \((P=0.03)\). Serial changes in heart rate were significantly different between groups \((P=0.01)\). Serial changes in metaraminol consumption were similar in the two groups.](image-url)
No problems related to the anaesthetic were identified at routine follow-up the day after surgery.

Comment
Our study showed that preload with gelatin solution 15 ml kg⁻¹ improved haemodynamic stability during spinal anaesthesia for Caesarean section when arterial pressure was maintained with a metaraminol infusion. This was evident in the lower maximum infusion rate and the smaller early vasopressor consumption required to maintain arterial pressure in the target range and the smaller maximum reduction in SAP in the colloid group compared with the control group. Furthermore, colloid preload reduced the incidence of nausea and vomiting. Therefore, preload with a colloid may be advantageous in patients in whom large fluctuations in arterial pressure and heart rate and large doses of vaspressors need to be avoided.

However, preload with colloids has potential disadvantages, including cost and the risks of haemodilution, fluid overload and anaphylactoid reactions. Therefore, in healthy patients, some clinicians may prefer to rely on vasopressors alone and not to use colloids routinely. This approach appears safe because we found neonatal outcome in the control group was as good as in the colloid group. However, the increased early vasopressor requirement in non-preloaded patients should be noted.

Our findings are similar to those of a previous study in which we investigated preload with 20 ml kg⁻¹ of crystalloid using a similar method. In both of these studies, we chose to maintain arterial pressure with an infusion of metaraminol. Although ephedrine has been recommended more commonly as a vasopressor in obstetrics, we have shown previously that an infusion of metaraminol results in less fetal acidosis than an infusion of ephedrine.

Some patients in our study had isolated and transient low arterial pressures recorded. This was not associated with adverse neonatal outcomes and might have been avoided by starting the vasopressor infusion earlier rather than waiting for the initial decrease in arterial pressure, as specified in our protocol.

In summary, we found that when maternal arterial pressure was maintained with an infusion of metaraminol, colloid preload improved haemodynamic stability and reduced maternal nausea and vomiting but had no effect on neonatal outcome.

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References
1 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

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