Haemodynamic consequences and uterine contractions following 0.5 or 1.0 litre crystalloid infusion before obstetric epidural analgesia

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Purpose: The efficacy of infusion of 0.5 L and 1.0 L Ringer's lactate (LR) to prevent hypotension during induction of obstetric analgesia was studied. The effect of the different fluid boluses on fetal heart rate (FHR) and frequency of uterine contractions were also determined.

Methods: Ninety-two ASA 1–2 parturients were randomized to receive 0.5 L (Group 1) and 1.0 L (Group 2) LR immediately before incremental epidural injections with lidocaine to achieve T₁₀ sensory block. Systolic blood pressure (SBP) was measured with an automated BP cuff every two minutes for 30 min after infusion of fluid bolus. Fetal heart rate monitoring and tocometry were used continuously. The number of uterine contractions were recorded 30 min before and 60 min after iv bolus.

Results: The SBP decreased in both groups, but there was no difference between groups in mean SBP or maternal heart rate. The incidence of hypotension (SBP < 90 mmHg or decrease of 20%) was 4% in both groups. The FHR record of a patient in Group 1 showed a single late deceleration, and a decrease in beat-to-beat variability occurred in one patient in Group 2. A decrease in the frequency of uterine contractions of two or more contractions per 30 min was noted more frequently in Group 2 ($P < 0.05$). The duration of iv bolus was

longer in Group 2 than Group 1 (18.8 ± 4.3 min vs 12.3 ± 4.5 min, $P < 0.01$).

Conclusion: Administration of 1.0 L LR iv does not provide added protection against maternal hypotension, and is associated with delay in providing pain relief and a risk of decreasing uterine contraction frequency.

Objectif: L'étude porte sur l'efficacité d'une perfusion intraveineuse rapide de lactate de Ringer (LR) de 0,5 L comparée à celle de 1,0 L administrées pour la prévention de l'hypotension au moment de l'induction de l'analgésie obstétricale. Les effets des deux vitesses de perfusion sur la fréquence cardiaque foetale (FCF) et la fréquence des contractions utérines ont aussi été déterminées.

Méthodes: Quatre-vingt-douze parturientes ASA 1 et 2 ont été réparties de façon aléatoire pour recevoir 0,5 L (Groupe 1) ou 1,0 L (Groupe 2) de LR immédiatement avant l'injection épidurale fractionnée de lidocaïne jusqu'à la progression à T₁₀ du bloc sensitif. La pression artérielle systolique (PAS) a été mesurée avec un manomètre automatique aux deux minutes pour 30 min après la perfusion. Le monitoring de la fréquence cardiaque foetale et la tocométrie ont été enregistrés en continu. La fréquence des contractions utérines a été enregistrée 30 min et 60 min après la perfusion.

Résultats: La PAS a diminué dans les deux groupes mais on n'a pas constaté de différence au regard de la PAS moyenne et de la fréquence cardiaque maternelle. L'incidence de l'hypotension (PAS < 90 mmHg ou une baisse de 20%) a été de 4% dans chaque groupe. Une décélération tardive de la FCF est survenue chez une patiente du groupe 1. Une baisse de variabilité du rythme est survenue chez une patiente du groupe 2. Une diminution de la fréquence des contractions utérines de deux contractions ou plus aux 30 min a été fréquente dans le groupe 2 ($P < 0,05$). La durée de la perfusion a été plus lente dans le groupe 2 que dans le groupe 1 ($18,8 \pm 4,3$ min vs $12,3 \pm 4,5$ min, $P < 0,01$).

Key words

ANAESTHESIA: Obstetric;
ANAESTHETIC TECHNIQUES: epidural;
FLUID THERAPY: infusion, parenteral.

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Conclusion: *L'administration de 1,0 L de LR ne procure pas de protection supplémentaire contre l'hypotension maternelle et peut retarder le soulagement de la douleur et diminuer la fréquence des contractions utérines.*

Epidural analgesia is a common and popular mode of pain relief during labour. Maternal hypotension is the most frequent side-effect of epidural administration of local anaesthetic solutions. Prophylactic intravenous infusion of a fluid bolus decreases the incidence of maternal hypotension and associated fetal heart rate abnormalities.^{1,2} There is no randomized study comparing the efficacy of different volumes of *iv* crystalloid solution in preventing maternal hypotension following epidural labour analgesia. Administration of at least 0.5 L isotonic saline is recommended as initial therapy to stop premature uterine contractions before tocolytic drug therapy.³ The effect of epidural analgesia on uterine activity and the progress of labour is controversial.⁴⁻⁹ Two reports describe a temporary decrease in uterine activity lasting up to 30 minutes after induction of epidural analgesia.^{10,11}

We designed a prospective, randomized study to determine the efficacy of 0.5 L and 1.0 L LR to prevent maternal hypotension during induction of epidural analgesia with lidocaine. The second objective of the study was to assess the frequency of uterine contraction following an *iv* bolus of 0.5 L and 1.0 L LR before epidural pain relief with lidocaine.

Methods

Approval of the study protocol was obtained from the Research and Ethics Committee at the Ottawa Civic Hospital. Informed, written consent was obtained from healthy parturients requesting epidural analgesia after admission to the birthing unit or in the first stage of labour. Women of ASA physical status 1-2 in the first stage of labour with singleton fetuses were included in the study. Parturients who had received more than 50 ml · hr⁻¹ of LR solution *iv* before or during labour were excluded from the study. Patients with pregnancy induced hypertension, pre-eclampsia, allergy to lidocaine, body weight >90 kg or other contraindication to epidural analgesia were excluded. The parturients were randomized to receive either 0.5 L (Group 1) or 1.0 L (Group 2) of warm LR prior to induction of epidural analgesia. Intravenous access was established with a #18 gauge catheter. Cervical dilatation was measured prior starting the *iv* infusion. The time taken to infuse the LR was noted. Baseline haemodynamic data (systolic blood pressure and heart rate) were obtained after infusion of crystalloid solution using an automated non-

invasive blood pressure device (Dinamap, Critikon, Tampa FL.). The epidural catheter was inserted at the L₂₋₃ or L₃₋₄ interspace and the parturient was placed supine with left uterine displacement using a standard device. The first dose of epidural local anaesthetic was injected immediately after the completion of the *iv* bolus of LR. Lidocaine 2% with 1:200 000 epinephrine was administered in increments of 3 ml, 4 ml and, if necessary, further aliquots of 3 ml at five minute intervals to achieve a T₁₀ sensory block and pain relief. This solution was used routinely in our institution for induction of obstetric epidural analgesia when this study was done. Blood pressure and heart rate were measured every two minutes for 30 min after the first injection of epidural lidocaine. Following completion of the study period epidural analgesia was maintained with continuous infusion of bupivacaine. Electronic monitoring of fetal heart rate (FHR) and uterine contractions was employed continuously except during insertion of the epidural catheter. Data from the continuous printout of FHR and uterine contractions were assessed after completion of the study by an investigator blinded to study group and neonatal outcome. The number of contractions during the 30 min period prior to start of the *iv* fluid bolus was recorded. The number of contractions during the first 30 min and from 30 to 60 min after the start of epidural lidocaine injections were noted. A decrease or increase of greater or equal to two contractions per 30 min period was considered important. The data from the FHR monitor were also assessed in a blinded fashion for beat-to-beat variability and incidence of late decelerations. Hypotension was defined as systolic blood pressure (SBP) <90 mmHg or a decrease of >20% from baseline SBP. Hypotension was treated with further LR and/or increments of ephedrine *iv* at the discretion of the attending anaesthetist.

Approximately 30% of patients experience hypotension during Caesarean delivery with epidural anaesthesia.¹² We extrapolated these findings to our study and considered a 50% relative decrease in the incidence of hypotension between study groups to be significant. Using an α of 0.05 and a power of 0.80, each group required 134 patients. Block randomization was used and interim analysis was performed after the first block of 90 patients had completed the study.

Demographic data were analyzed with Student *t* test and chi-square where appropriate. Haemodynamic data were assessed using repeated measures analysis of variance (ANOVA) with Tukey's HSD post hoc tests. The change in the frequency of uterine contractions after *iv* infusion of LR was determined using chi-square analysis. *P* < 0.05 was considered statistically significant.

Results

The study was terminated after data from the first 92 patients were analyzed; 46 patients received 0.5 L LR and 46 received 1.0 L LR prior to induction of epidural analgesia with lidocaine 2%. The mean age, weight, height, gestational age and cervical dilatation of parturients did not differ between study groups (Table I). There was no difference between the two groups in the amount of epidural lidocaine administered to achieve T₁₀ sensory block. However, the duration of *iv* infusion was longer in Group 2 than in Group 1 ($P < 0.05$).

Systolic blood pressure decreased following induction of epidural analgesia in both groups. The SBP measured 10 min after the start of epidural lidocaine injections was lower than baseline SBP obtained before administration of epidural lidocaine in Group 1 and Group 2 (Figure). However, there was no difference in mean SBP between study groups at any time during the study period. Two parturients in each study group developed maternal hypotension, and one FHR recording from Group 1 and one from Group 2 showed evidence of fetal distress (Table II). There was no difference between groups in maternal heart rate. The maternal heart rate was higher in both study groups at the end of the study period than the baseline values before induction of epidural analgesia ($P < 0.05$).

Ten records of FHR before and/or after administration of epidural analgesia were missing; hence the records of 82 FHR recordings were analyzed in a blinded fashion. There was no change in beat-to-beat variability or evidence of late decelerations in any FHR tracings except in two recordings (Table II). A further eight records were of poor quality making the determination of frequency of uterine contractions impossible. Therefore, 74 records were available for analysis of contraction frequency in the 0–30 min period after the first epidural injection of lidocaine. The data indicated that the number of parturients who experienced a decrease in the frequency of uterine contractions during the 30 min period after the fluid bolus and induction of epidural analgesia was higher in Group 2. (Table III). This trend continued during the 30–60 min period after the first epidural injection of lidocaine.

Discussion

Rapid infusion of crystalloid or colloid solution is recommended prior to induction of epidural analgesia for labour and epidural anaesthesia for Caesarean section to prevent maternal hypotension resulting from peripheral vasodilatation associated with sympathetic blockade. Our data demonstrate that maternal hypotension is an infrequent complication (4%) after incremental injections of lidocaine following 0.5 L or 1.0 L *iv* bolus of

TABLE I Demographic data

	Group 1 (n = 46)	Group 2 (n = 46)
Age (yr)	28.9 ± 5.4	28.6 ± 5.6
Weight (kg)	75.2 ± 9.8	74.5 ± 9.5
Height (cm)	163.7 ± 6.6	164.7 ± 6.4
Gestational age (wk)	39.5 ± 3.4	39.6 ± 1.2
Cervical dilatation (cm)	4.5 ± 2.2	4.0 ± 1.4
LR infusion time (min)	12.3 ± 4.5	18.8 ± 4.3*
Lidocaine (ml)	9.8 ± 1.1	10.1 ± 1.3
Duration of fasting (hr)	5.3 ± 5.6	5.4 ± 3.9

* $P < 0.01$ for duration of infusion of 1000 vs 500 ml – Student's *t* test.

FIGURE A comparison of mean systolic blood pressure over time for each group. There were no differences between groups, however both groups decreased significantly from baseline (BL) starting 10 min after induction of epidural analgesia. * $P < 0.01$ vs BL using ANOVA.

TABLE II Parturients with hypotension during study period

	Duration of hypotension	Treatment	Change in FHR tracing after epidural analgesia
Group 1:			
– Patient A	2 min	<i>iv</i> LR	Single late deceleration
– Patient B	2 min	<i>iv</i> LR + ephedrine 5 mg	None
Group 2			
– Patient A	8 min	<i>iv</i> LR + ephedrine 5 mg	Poor beat-to-beat variability
– Patient B	2 min	<i>iv</i> LR	None

LR with the parturient positioned supine with left uterine displacement. There was no difference between the study groups in mean systolic blood pressure at any time during the study period and there was no difference in the incidence of hypotension. Hence, infusing 1.0 L

TABLE III Uterine contraction frequency per 30 min after completion of fluid bolus

	Group 1	Group 2
0–30 min post <i>iv</i> bolus	(n = 37)	(n = 37)
– No change	18	19
– Increase ≥ 2	13	5*
– Decrease ≥ 2	6	13*
30–60 min post <i>iv</i> bolus	(n = 36)	(n = 36)
– No change	21	15
– Increase ≥ 2	7	8
– Decrease ≥ 2	8	13†

* $P < 0.01$ Group 1 vs Group 2 using chi-square, comparing the incidence of no change vs an increase or a decrease in contraction rate.

† $P < 0.05$ Group 1 vs Group 2 using chi-square, comparing the incidence of a decrease in contraction rate with the combination of an increase or no change in uterine contraction frequency.

Note: There was no difference in uterine contraction frequency between groups in the 30 min prior to start of *iv* fluid bolus.

rather than 0.5 L LR delayed administration of epidural analgesia, but did not provide further protection against maternal hypotension associated with induction of epidural block.

Previous studies showed that the incidence of maternal hypotension after spinal anaesthesia for Caesarean delivery without infusion was 92%, whereas the incidence was reduced to 53% with *iv* infusion of 1.0 L of crystalloid solution.¹³ The incidence of hypotension after induction of epidural anaesthesia for Caesarean section was 29–45% with acute *iv* hydration with 1.0–1.2 L of crystalloid solution.^{14–16} Lewis *et al.*¹⁷ found that only 6.7% of parturients experienced hypotension after rapid infusion of 2.0 L crystalloid solution. Prophylactic administration of *iv* colloid solution rather than crystalloid solution is not associated with a decreased incidence of maternal hypotension.^{15,17} The incidence of maternal hypotension following neuraxial blockade at Caesarean section is less in labouring parturients than in women who present for elective Caesarean section.^{13,16} This indicates that data from studies at Caesarean section in non-labouring parturients cannot be extrapolated to the administration of epidural analgesia for women in labour. Also, adequate pain relief during labour will result from a T₁₀ sensory block; whereas a T₆ sensory block is required for Caesarean section. In addition, previous studies of the haemodynamic consequences of regional blockade for Caesarean section examined parturients receiving spinal or single bolus epidural anaesthesia. The only randomized study to examine the effect of fluid loading before epidural analgesia for labour found a decrease in the incidence of maternal hypotension from 28% to 2% with an intra-

venous load of 1.0 L of Hartmann's solution immediately before epidural bolus injection of 10 ml bupivacaine 0.375%.¹ Crawford¹⁸ has demonstrated a lower incidence of maternal hypotension with incremental epidural injections of bupivacaine rather than single bolus injections of local anaesthetic solution prior to Caesarean section.

Our results confirm the potential detrimental effect of maternal hypotension due to epidural blockade since the two parturients with abnormal FHR recordings both experienced hypotension during induction of epidural pain relief. Previous studies have demonstrated that the incidence of fetal heart rate abnormalities is reduced following infusion of crystalloid solution immediately before epidural blockade.^{1,2}

The effect of epidural analgesia on uterine activity and duration of first stage of labour is controversial. A non-randomized study by Read *et al.*⁴ found slower rates of cervical dilatation in women receiving epidural analgesia with bupivacaine than in women who received parenteral meperidine or no analgesics. Thorp *et al.*⁵ studied nulliparous women and randomized them to receive epidural analgesia with bupivacaine or *iv* meperidine. The mean duration of first stage of labour was increased by 30% in the epidural study group compared with women who received *iv* meperidine. Lowensohn *et al.*¹⁰ and Wildeck-Lund *et al.*¹¹ described a decrease in uterine activity following epidural lidocaine injection at 10 and 20 min after injection. Uterine activity returned to baseline value 30 min after injection of lidocaine.

However, Guidozi *et al.*⁶ did not find any negative effect of epidural analgesia on uterine work during the active phase of first stage of labour. Similarly, Abboud *et al.*⁷ failed to identify any change in uterine activity after epidural injection of bupivacaine, chloroprocaine or lidocaine. Chestnut *et al.*^{8,9} have recently demonstrated that early administration of epidural analgesia did not prolong labour in nulliparous women compared with women receiving nalbuphine analgesia *iv*.

The results from our study show that rapid *iv* infusion of 1.0 L LR prior to establishment of epidural analgesia is associated with a decrease in the frequency of uterine contractions in some women. Intravenous infusion of 0.5 L was not associated with a change in uterine contraction frequency. Thus, the temporary decrease in uterine activity immediately after induction of epidural analgesia may result from a larger *iv* fluid load rather than as a consequence of the epidural procedure per se. It is common practice to limit oral intake of food and fluids during labour in our birthing unit, and the mean duration of fasting was five hours in our study patients. Therefore *iv* administration of 0.5 L LR represented

only a compensation for fluid deficit resulting from restricted oral intake. Intravenous hydration with saline is used for initial treatment of pre-term labour.³ This recommendation was based on a study by Goodlin¹⁹ which showed that some pre-term women were hypovolaemic and that *iv* administration of albumin restored their intra-vascular volume and delayed delivery. Valenzuela *et al.*²⁰ and Pircon *et al.*²¹ found that contractions stopped in 55% of parturients with pre-term contractions treated with an *iv* fluid bolus and bed rest or sedation. It has been suggested that intra-vascular volume expansion decreases secretion of both vasopressin and oxytocin from the posterior pituitary.²²

In summary, the mean decrease in systolic blood pressure and incidence of hypotension during the first 30 min after induction of incremental epidural analgesia with lidocaine was not different between the study groups. Hence, a volume of 1.0 L LR did not provide further protection against maternal hypotension and fetal heart rate abnormalities than did the administration of 0.5 L LR before induction of epidural analgesia. The infusion of 1.0 L LR immediately before induction of epidural analgesia is, however, associated with a decrease in frequency of uterine contractions in some women, whereas infusion of 0.5 L LR is not. We recommend *iv* administration of 0.5 L LR before epidural labour analgesia. Further *iv* volume loading does not provide added protection against maternal hypotension, delays pain relief and is associated with an increased risk of reducing the frequency of uterine contractions.

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