Epidural anaesthesia for elective Caesarean section does not influence fetal umbilical artery blood flow indices

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This prospective study was completed to determine the influence of epidural anaesthesia on the fetoplacental circulation of normal subjects. Thirty-seven normal pregnant patients at term, undergoing elective Caesarean section, had Doppler measurements of the fetal umbilical artery blood flow velocity before and after epidural anaesthesia using lidocaine 2% without epinephrine. There were no differences in systolic/diastolic, resistance or pulsality indices following epidural anaesthesia. These results suggest that this technique has no adverse effect on fetoplacental circulation in normal non-labouring subjects.

Cette étude prospective a pour but de déterminer l'influence de l'anesthésie épidurale sur la circulation foeto-placentaire dans le contexte d'une grossesse normale. Des indices de vélocité du flot de l'artère ombilicale foetale ont été mesurés par Doppler chez trente-sept patientes gravides à terme, sans complications, programmées pour une césarienne élective, avant et après une anesthésie épidurale utilisant la lidocaïne 2% sans épinéphrine. Les indices de rapport systole/diastole, de résistance et de pulsatilité sont demeurés inchangés après l'induction de l'anesthésie épidurale. Ces constatations suggèrent que l'anesthésie épidurale n'a pas d'influence sur la circulation foeto-placentaire chez des patientes enceintes normales à terme qui ne sont pas en travail.

Key words
ANAESTHESIA: obstetric;
ANAESTHESIA TECHNIQUE: epidural;
BLOOD: flow velocity, umbilical artery;
MEASUREMENT TECHNIQUES: Doppler, continuous;
PLACENTA: circulation.

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Epidural anaesthesia is an established method of anaesthesia for Caesarean section. Since the introduction of epidural anaesthesia, the risks of maternal aspiration and neonatal drug depression have been reduced drastically.[1] Furthermore, it has been possible for the mother and father to witness the birth of their child.[2] However, fetoplacental circulation may potentially be altered[3] by maternal haemodynamic changes secondary to epidural anaesthesia, despite intravenous pre-load and adequate maternal positioning.

Fetal umbilical artery blood velocity indices (Figure) have been used to quantitate resistance to flow in the feto-placental circulation, especially in diastole. Normally, at term, diastolic flow in the fetal umbilical artery is elevated, thus permitting better circulation and exchange throughout the cardiac cycle at the level of the placenta. The systolic and diastolic flow pattern resembles that of an arterial-venous fistula. Different clinical situations have been associated with decreased, absent or reversed diastolic flow, representing worsening grades of fetal compromise.

Morrow *et al.* have studied the influence of epidural anaesthesia on systolic/diastolic ratio (S/D) of the fetal umbilical artery at term.[4] Although no change in S/D ratio was found, the study was based on only 12 subjects, and lidocaine and epinephrine were used to achieve adequate anaesthesia. Baumann *et al.*[5] demonstrated an increase in uteroplacental blood flow indices in 11 of 13 patients undergoing epidural anaesthesia using lidocaine with epinephrine at term. In this study, no change was seen in the umbilical artery circulation but the study was based on a small number of subjects undergoing Caesarean section for diverse indications. Other studies used

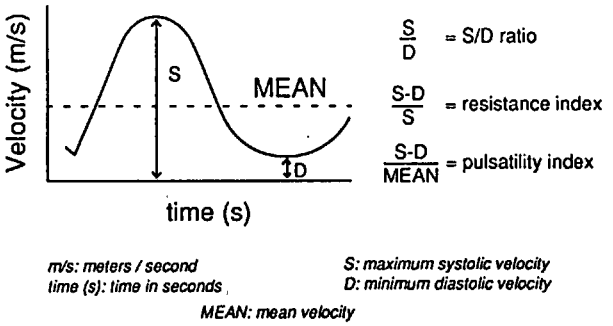

FIGURE The schematic arterial waveform with different blood flow velocity indices.

different anaesthetics in labouring patients. It is the goal of this study to evaluate the influence of epidural anaesthesia using only lidocaine on fetal umbilical artery flow prior to elective Caesarean section in healthy pregnancies at term using non-invasive Doppler methods.

Methods

The following study was approved by our institutional Research and Ethics Committee. After written informed consent, 37 non-labouring patients scheduled for elective Caesarean section at 38 or 39 wk were included in this prospective study. All were uncomplicated singleton gestations, i.e, without diabetes, anaemia, hypertension, intra-uterine growth retardation, insufficient anaesthesia or known fetal anomalies. Prior to anaesthesia, all patients were given a 30 ml solution of sodium citrate, 3.0 M *po*. The patients were placed in the supine position with a left lateral tilt. Using a Multigon 500 continuous wave Doppler, the fetal umbilical artery was identified using its characteristic flow velocity pattern.[6] As measurements of flow velocity are dependent on the angle at which reflected signals are obtained, it was essential to use ratios of measurements to eliminate the possible error related to the angle. Flow velocity indices (Figure) are angle-independent and, therefore, have been used clinically to outline fetal umbilical circulation for over a decade. The following indices (Figure) of umbilical artery blood flow velocity were measured prior to placement of the epidural catheter: systolic/diastolic (S/D) ratio, pulsatility and resistance indices. Using this technique, an average variation of 6% could be anticipated.[6] The indices were all computed simultaneously, using the software package accompanying the Doppler instrument. Reported values represent the mean of three consecutive measurements of three cardiac cycles each.

Epidural anaesthesia was then performed using the same technique for all patients. After an intravascular preload of one to two litres Ringer's lactate with the patient in the sitting position, an epidural catheter was placed in the L_2–L_3, or L_3–L_4 lumbar intervertebral space. Immediately after, the patient was placed in the supine position with a left lateral tilt. Incremental doses of lidocaine 2% without epinephrine ranging from 360 mg to 520 mg were injected to produce the desired level (T_4) of anaesthesia for surgery. Vital signs were monitored every two minutes during induction of anaesthesia using an automated blood pressure monitor, continuous ECG and pulse oximeter. As soon as the level was verified at T_4 using needle prick and/or ice, the Doppler measurements were repeated. A paired t test was used to compare measurements before and after epidural anaesthesia. A level of $P < 0.05$ was considered significant.

TABLE Fetal umbilical artery flow velocity indices before and after epidural anaesthesia for elective Caesarean sections at term as experienced as means ± standard deviation

Indices n = 37	*Before epidural*	*After epidural*	
S/D	2.26 ± 0.24	2.26 ± 0.3	NS
Resistance index	0.57 ± 0.04	0.57 ± 0.07	NS
Pulsatility index	0.83 ± 0.10	0.83 ± 0.16	NS

NS: Not significant.

Results

The mean maternal age was 31.5 ± 3 yr (μ ± SD). The gestational age at delivery was 38.9 ± 0.9 wk and the mean birthweight was 3291 ± 229 g. There were no statistical or clinical differences in indices before and after epidural anaesthesia (Table). The median interval between placing the catheter and achieving the level of anaesthesia required for surgery was 22 minutes, ranging from 17 to 36 mins. The median interval between Doppler measurements was 29 mins, with a range of 23 to 44 mins. Five patients required five to ten milligrams ephedrine to correct hypotension of no more than three minutes duration before surgery. This was diagnosed after a decrease in systolic of approximately 25 mmHg or diastolic of 15 mmHg in maternal blood pressure readings. None of these hypotensive patients had levels of anaesthesia above T_4. Two of these patients experienced palpitations and weakness. In these two, Doppler measurements were taken during the hypotensive period, and no difference in indices was noted from the measurements prior to anaesthesia. All maternal and neonatal outcomes were normal. There were no complications related to epidural anaesthesia.

Discussion

The fetoplacental unit is a low resistance, high-flow vascular system. Increases in resistance in this compartment are associated with decreased umbilical artery flow, and

eventually decreased fetal oxygenation. This increase in resistance is detectable as an increase in the three Doppler indices we have evaluated. Marx *et al.*[7] have shown that, in labour, epidural anaesthesia was associated with a decrease in S/D ratio of the fetal umbilical artery flow velocity in healthy parturients. This is compatible with a decrease in vascular resistance in the fetoplacental unit. They suggested that this advantageous result was secondary to a decrease in maternal adrenergic response associated with pain relief. However, using a different technique, Jouppila *et al.*[8] have shown a reduction in placental blood flow in the same circumstances in a small group of patients. This may be attributable to different medications[9,10] and their concentrations in the induction of epidural anaesthesia in the two studies. Furthermore, in the later study, the subjects were noted to have severe hypotension. In another small series, Giles *et al.*[11] demonstrated a decrease in the S/D ratio after induction of epidural anaesthesia with bupivicaine without epinephrine in normal patients undergoing elective Caesarean section. Although this may be considered a beneficial effect, this may also be secondary to the cardiac depression caused by this agent.[12]

In the clinical situation investigated in our study, pain was not a cofactor since epidural anaesthesia was used for elective Caesarean section at term. Therefore, unlike the study of Marx *et al.*,[7] we would not expect to observe a variation in placental resistance. Our findings may also differ from those of Giles *et al.*,[11] because of the use of lidocaine rather than bupivicaine.[12] Bupivicaine has been shown to have up to 20 times the negative inotropic effect of lidocaine and, therefore, has been considered a cardiac depressive agent.

After general anaesthesia, Jouppila *et al.*[13] have demonstrated a reduction of placental intervillous flow. Tracheal intubation stimulates a positive-pressure response[14] that decreases uterine blood flow during elective Caesarean section at term. Circulating levels of epinephrine correlate well with these pressure responses.[15,16] Therefore, these findings may favour use of epidural anaesthesia in these circumstances.

A continuous wave Doppler was used throughout this study. Recognition of the umbilical artery was easily performed. The indices reported were the mean of three measurements of three cycles each. This was to lower variations in test results. Only two experienced authors completed all the measurements. This was accomplished in an effort to decrease variation in Doppler measurement. Brar *et al.*[17] demonstrated that continuous-wave Doppler measurements produced similar results as pulsed Doppler measurements of the umbilical artery flow velocity. Therefore, this study would not have benefited from the addition of pulse Doppler indices.

When the uterus is not contracting, uteroplacental blood flow is not autoregulated.[18] There is almost maximum vasodilatation of the arterioles feeding the placental bed. Therefore, a considerable decrease in maternal blood pressure could affect maternal supply to the placenta. The reported incidence of hypotension following epidural anaesthesia will vary according to the definition of hypotension, the type of prophylaxis, the extent of epidural block and the frequency of blood pressure monitoring.[3] Nonetheless, hypotension following adequate preload and positioning of the mother is not frequent (6.7%).[19] Consequently, in our study, hypotension was not anticipated and, therefore, this was not used as an outcome measure. The two patients that were symptomatic were evaluated at the time of treatment with ephedrine. No difference in flow indices was observed at that time as compared to the protocol measurements. Although it would have been useful to have continuous monitoring of indices throughout the interval between the first and second measurements, this would have been technically difficult. Firstly, it would be difficult to achieve during the placement of the epidural catheter with the patient in the sitting position. Secondly, subjecting patients throughout the induction of anaesthesia would have increased this exposure and could also have decreased enrolment in our study.

This study included 37 patients. There were no statistical or clinical differences in flow velocity indices before and after epidural anaesthesia for elective Caesarean section at term. Veille *et al.*[20] used 2-chloroprocaine with epinephrine to achieve the desired level of anaesthesia. Our study reviewed the influence of lidocaine without epinephrine on umbilical flow indices, which has not previously been reported. Similar results were reported by Morrow *et al.*[4] when using lidocaine with epinephrine. Baumann *et al.*[5] have shown an increase in indices in the uteroplacental circulation, but not in the umbilical blood flow, using lidocaine 2% with epinephrine. Our study has twice the number of subjects as that of Veille,[20] Morrow[4] and Baumann,[5] who had similar findings. Therefore, increasing enrolment would not be likely to change the results of our study.

In our study, the use of Doppler ultrasound did not demonstrate any effect of lidocaine 2% without epinephrine during epidural anaesthesia on the fetal umbilical artery flow velocities.

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