The Effects of Epidural Analgesia on Obstetric Outcomes, Uterine and Umbilical artery Doppler in Labor

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Abstract

BACKGROUND Epidural analgesia for labor and delivery involves the injection of a local anesthetic agent and an opioid analgesic agent into the lumbar epidural space. Hypotension threatens the fetus by decreasing uterine blood flow. Modest decreases (≤ 20 %) in maternal blood pressure are of limited concern in a woman with a healthy fetus. The increase in vascular flow resistance by color Doppler (uterine artery pulsatility index) UtA-PI is positively correlated to the intrauterine pressure produced by contractions. Under normal circumstances the umbilical artery blood flow is not affected by uterine contractions. Aim of the study: This study aimed to compare the effects of epidural analgesia by using bupivacaine and fentanyl in the obstetric outcomes, uterine and umbilical artery Doppler with patients underwent normal labor. METHODS: The study included 40 full pregnant females divided into two equal groups, 20 patients for each underwent normal labor. In (group I) patients go to labor ward directly without analgesia. In (group II) patients with epidural analgesia received (bupivacaine + fentanyl). The following parameters was compared between the 2 groups: labor criteria, maternal mean arterial blood pressure, uterine artery pulsatility index (UtA-PI) during uterine contractions and relaxation, umbilical artery pulsatility index (UA-PI) RESULTS: There was a significant decrease in mean arterial blood pressure at 15, 30, 45, 60 minutes and also the (UtA-PI) was decreased at 30 and 60 minutes during contraction only. The type of delivery, the (UA-PI) and Apgar score were comparable. CONCLUSIONS: Epidural analgesia using10 ml of 0.25% bupivacaine plus 50 μg fentanyl diluted in 5 ml saline significantly decreased maternal blood pressure at 15, 30, 45, 60 minutes and the placental blood flow at 30, 60 minutes after induction only during uterine contractions but these effects not affect the umbilical blood flow, labor outcomes and neonatal outcomes.

Introduction

In the first stage of labor The pain is caused by uterine contractions and distension of the cervix and low uterine and is transmitted through visceral afferent (sympathetic). Labor pain is referred to the dermatomes T(11) and T(12). Later in labor perineal stretching transmits painful stimuli through the pudendal nerve and sacral nerves S2 through S4. The maternal stress response can lead to increased release of corticotropin, cortisol, norepinephrine, β-endorphins, and epinephrine. Epidural analgesia for labour and delivery involves the injection of a local anesthetic agent and an opioid analgesic agent into the lumbar epidural space. The injected agent gradually diffuses across the dura into the subarachnoid space, where it acts primarily on the spinal nerve root and to a lesser degree on the spinal cord and paravertebral nerves. The most common complications occurring with epidural analgesia is maternal hypotension. Hypotension threatens the fetus by decreasing uterine blood flow. Modest decreases (≤ 20 %) in maternal blood pressure are of limited concern in a woman with a healthy fetus. The maternal blood supply to the placenta is intermittently strangled by myometrial contractions. A significant reduction in the perfusion pressure of the uterine artery blood flow is seen at the maximum pressure of the uterine contraction. In diastole, when intrarterial pressure exceeds maternal diastolic pressure especially if associated with hypotension, the perfusion pressure of the uterine artery blood flow is no longer present. The increase in vascular flow resistance by Doppler velocimetry as (uterine artery pustule pulsatility index) UtA-PI is positively correlated to the intrarterine pressure produced by contractions. Under normal circumstances the umbilical artery blood flow is not affected by uterine contractions.

Aim of the study:

This study aimed to compare the effects of epidural analgesia by using bupivacaine and fentanyl in the obstetric outcomes, uterine and umbilical artery Doppler with patients who underwent normal labor.

Patients and methods

This study was approved by the local Clinical Research Ethics Committee of Menoufiya hospital and written informed consent was obtained from the patients before the onset of labour analgesia. This study was performed in one year period from June 2012 till March 2013. Sixty full term pregnant females were included in the study classified as American Society of Anesthesiologists physical status I or II. The inclusion criteria included: age between 18-40 years, no significant medical or obstetric complications; normal platelet count and coagulation profile, singleton pregnancy, gestational age ≥37 weeks; with an engaged vertex presentation ; intact membrane; active labor with cervical dilatation ≥4 cm and uterine contractions occurring at least every 5 min; normal cardiotocography (CTG) [baseline fetal heart rate (FHR) between 110 and 160 beats/minute, baseline variability >5 beats/minute, presence of accelerations, and absence of decelerations. Exclusion criteria were: maternal age less than18 years or more than 40 years, poor parturient compliance, pre-eclampsia, gestational diabetes, cardiovascular diseases, psychiatric or neurological disorders, documented coagulation abnormality or abnormal bleeding history, evidence of infection or anatomic abnormality at catheter insertion site, delivery time is less than 120 minutes of study period, or fetal distress mandating urgent cesarean
delivery. Patients who had received opioids or known to have hypersensitivity to local anesthetic. Then the patients were divided into two groups 20 patients for each group. Group I (control group) where no analgesia was given and the patient was admitted immediately in the labor room and Group II (epidural analgesia group).

In the epidural analgesia group, the patient received 10 ml of 0.25% bupivacaine plus 50 μg fentanyl diluted in 5 ml saline as a one bolus. The epidural analgesia was administered in the labour ward under aseptic condition. An intravenous infusion of 500 ml of lactated Ringer’s solution was administered before the epidural injection. With the patient sitting position, a local infiltration was administrated to the skin and subcutaneous tissue. An epidural catheter was inserted into the L3–L4 vertebral interspace using the loss of resistance technique; 2–3 cm of catheter was introduced in the epidural space. With the patient in the supine position, a test dose of local anesthetic (4 ml of lidocaine) was administered through the catheter. Maternal arterial pressure and heart rate were monitored at 5 min intervals. Once it was determined that no adverse effects such as maternal hypotension or fetal bradycardia had occurred, the study drugs were then administered.

Pain intensity was assessed with a 10-cm linear visual analogue scale (VAS), where 0 represented ‘no pain’ and 10 represented ‘most severe pain’. Pain scores were determined just before epidural placement and 30, 60, 90 and 120 min after epidural injection. When VAS was ≥ 4, a second dose of analgesia was administered and the patient excluded from the study.

The pregnant females was monitored by non invasive blood pressure, oxygen saturation (pulse oximeter) and maternal pulse rates. The mean arterial blood pressure (MAP) were recorded every 15 minutes all of the study. The first measurement was obtained immediately before epidural dosing (baseline) between uterine contractions. Hypotension was defined as a 20% decrease in mean arterial pressure (MAP) and maternal bradycardia as pulse rate <60/minute. If a significant decrease in (MAP) occurred the patient will receive bolus of ephedrine (5 mg).

Color Doppler study for the uterine and umbilical arteries was performed in all patients using a color Doppler machine (Siemens Sonoline Sienna) with a 2.6 to 5 MHz convex trans-abdominal probe. Ultrasound Doppler indices were measured in uterine arteries and umbilical artery with the patient in the recumbent position by the radiologist.

Ultrasonic gel was applied to the skin of the lower abdomen. Doppler color flow mapping was used to highlight the uterine artery on the sides of the cervix and uterus at the level of the internal os. Pulsed-wave Doppler was used where uterine artery crossed the external iliac artery. When three similar, consecutive waveforms were obtained, the PI was measured and the mean UtA-PI was calculated. The umbilical artery Doppler flow spectrum was recorded from a free-floating central part of the umbilical cord. The mean of three consecutive blood velocity waveforms were analyzed for PI.

The probe angle was adjusted slightly until the signal is optimized in its quality and amplitude. The angle of insonation was always <60deg. Blood flow velocity measurements were taken with the sample volume set as narrow a possible and cursor positioned in the center of the bloodstream parallel to the vessel axis. Spectral wave analysis was done for the calculation of the pulsatility index (PI). Uterine artery pulsatility index (UtA-PI) and umbilical artery pulsatility index (UA-PI) during uterine relaxation and contraction was measured before (T0), 30 min (T30), 90 min (T90) and 120 min (T120) after the beginning of analgesia in the epidural group and at the beginning of labor (T0), 30 min (T30), 90 min (T90) and 120 min (T120) later in control group. The right and left uterine arteries were identified by color flow at the apparent crossover with the external iliac arteries, and pulsed-wave Doppler was used to obtain waveforms. When three similar, consecutive waveforms were obtained, the PI was measured and the mean UtA-PI calculated.

The fetus was monitored by continuous CTG. The type of delivery and the neonatal Apgar scores at 1, and 5 min was determined.

A power analysis and sample-size estimate was made for the previous studies. A study population of 40 patients was adequate. This allowed a power of 0.80 and an alpha error of 5%. Statistical analysis of data was carried out by minitab version 1.6 program. Data expressed in mean and standard deviation (mean±SD) as for all comparisons P < 0.05 was considered significant. Paired - Samples T test was used for quantitative data. Chi-square test used for qualitative data. Mann Whitney test for Apgar score analysis.

Results:
This study was carried on 40 patients, 20 patients for each group. 2 patients were excluded from each group. In the control group one labor before 120 minutes and one for emergent Caesarian section due to fetal distress. In the epidural group one for failed epidural replacement and the other required a second dose of local anesthetics.

Table 1: Demographic Data

<table>
<thead>
<tr>
<th></th>
<th>Control Mean ± SD</th>
<th>Epidural Mean ± SD</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal Age (years)</td>
<td>25.1 ± 5.6</td>
<td>26.2 ± 5.1</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Maternal Height (cm)</td>
<td>162 ± 8.6</td>
<td>164 ± 9</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Maternal Weight (Kg)</td>
<td>78.1 ± 11.1</td>
<td>76.5 ± 11.4</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Parity</td>
<td>2.2 ± 1.2</td>
<td>1.9 ± 1.2</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>
Cervical Dilatation (cm) | 4.5 ± 1.4 | 4.7 ± 1.5 | >0.05  
Gestational Age (weeks) | 39.2 ± 1.2 | 39.5 ± 1.3 | >0.05  
Birth Weight (grams) | 3089.2 ± 445 | 3112.4 ± 389 | >0.05  

Data expressed as mean and standard deviation (Mean±SD), Paired sample T test. * denotes statistical significance (P< 0.05)

Table (2): Labor Criteria

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Epidural</th>
<th>Chi-X</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spontaneous Labor</td>
<td>16/18</td>
<td>13/18</td>
<td>0.206</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Instrumental Vaginal Delivery</td>
<td>1/18</td>
<td>3/18</td>
<td>0.289</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Cesarean Section</td>
<td>1/18</td>
<td>2/18</td>
<td>0.546</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Oxytocin for Labor Augmentation</td>
<td>4/18</td>
<td>6/18</td>
<td>0.457</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>

Chi-Square test  
* denotes statistical significance (P< 0.05)

Figure (1): mean arterial blood pressure (mmHg)
Data expressed as mean and standard deviation (Mean±SD), Paired sample T test. * denotes statistical significance (P< 0.05)

### Table (3): UtA-PI (Relaxation)

<table>
<thead>
<tr>
<th></th>
<th>Control mean ± SD</th>
<th>Epidural mean ± SD</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (min)</td>
<td>0.653 ± 0.019</td>
<td>0.668 ± 0.018</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>30 (min)</td>
<td>0.627 ± 0.014</td>
<td>0.749 ± 0.025</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>60 (min)</td>
<td>0.621 ± 0.017</td>
<td>0.741 ± 0.025</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>90 (min)</td>
<td>0.659 ± 0.019</td>
<td>0.722 ± 0.014</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>120 (min)</td>
<td>0.654 ± 0.011</td>
<td>0.688 ± 0.017</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>

Data expressed as mean and standard deviation (Mean+SD), Paired sample T test. * denotes statistical significance (P< 0.05)

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**Figure (2): UtA-PI during contraction**

Data expressed as mean and standard deviation (Mean±SD), Paired sample T test. * denotes statistical significance
Table (4): UA-PI (Relaxation)

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Control mean ± SD</th>
<th>Epidural mean ± SD</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.812 ± 0.007</td>
<td>0.817 ± 0.011</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>30</td>
<td>0.781 ± 0.007</td>
<td>0.814 ± 0.010</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>60</td>
<td>0.792 ± 0.013</td>
<td>0.82 ± 0.008</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>90</td>
<td>0.792 ± 0.012</td>
<td>0.81 ± 0.028</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>120</td>
<td>0.789 ± 0.025</td>
<td>0.824 ± 0.013</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>

Data expressed as mean and standard deviation (Mean± SD), Paired sample T test. * denotes statistical significance (P< 0.05)

Table (5): UA-PI (Contraction)

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Control mean ± SD</th>
<th>Epidural mean ± SD</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.982 ± 0.013</td>
<td>0.96 ± 0.014</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>30</td>
<td>0.978 ± 0.018</td>
<td>0.993 ± 0.008</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>60</td>
<td>0.977 ± 0.008</td>
<td>0.98 ± 0.011</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>90</td>
<td>0.975 ± 0.011</td>
<td>0.978 ± 0.006</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>120</td>
<td>0.973 ± 0.012</td>
<td>0.976 ± 0.007</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>

Data expressed as mean and standard deviation (Mean± SD), Paired sample T test. * denotes statistical significance (P< 0.05)

Table (6): Apgar score

<table>
<thead>
<tr>
<th>Time</th>
<th>Control</th>
<th>Epidural</th>
<th>Mann-Whitney</th>
</tr>
</thead>
<tbody>
<tr>
<td>At 1 min</td>
<td>9 (8 – 10)</td>
<td>9 (8 – 10)</td>
<td>Not significant</td>
</tr>
<tr>
<td>At 5 min</td>
<td>9 (8 – 10)</td>
<td>9 (8 – 10)</td>
<td>Not significant</td>
</tr>
</tbody>
</table>

Data expressed as median and range Mann-Whitney was used.

Discussion:
Labour is painful for majority of mothers and extremely painful for some. The amount of pain experienced by a woman during labour and delivery can be influenced by many factors, including participation in child birth preparation classes, parity and use of oxytocin. A variety of analgesic techniques are available such as psychological techniques, systemic medication, inhalational anesthesia and regional anesthesia. Among various analgesic options, lumbar epidural analgesia is a safe and effective method and for most women provides unparalleled relief from the pain of labor and delivery.[10]

In this study, the effects of epidural analgesia in normal labour versus control group was tested as regards the type of the delivery, maternal mean arterial blood pressure (MAP) every 15 minutes, uterine artery pustule index (UA-PI) every 30 minutes during uterine contractions and relaxations, the umbilical artery pustule index every 30 minutes during uterine contractions and relaxations and the fetal outcomes.

In the present study the results of demographic data were of no significance or concern in both two groups.

As regards the type of the delivery (spontaneous labour, instrumental delivery, Cesarean delivery and the use of oxytocin for labour augmentation) there was no statically significance difference between the two groups.

A Cochrane review of 20 trials involving a total of 6534 women estimated that the relative risk of cesarean delivery with epidural analgesia as compared with other methods or with no analgesia was 1.07[11].

In the study done by Liu et al who compared the effect of continuous epidural analgesia versus systemic opioids on the rate of instrumental delivery and Cesarean section and concluded that no significance difference between the two groups[12].
In another study done by Halpern et al who also compared controlled epidural analgesia and intravenous analgesia in normal labour and they concluded that epidural analgesia does increase the duration of the second stage of labor by 15 to 30 minutes and may increase slightly the rate of instrument-assisted vaginal deliveries but not to a significant degree [13].

And also in another three randomized, controlled trials showed that early initiation of epidural analgesia in labor does not increase the rate of cesarean delivery among women with spontaneous or induced labour, as compared with early initiation of analgesia with parenteral opioids [14,15,16].

As regards the maternal mean arterial blood pressure (MAP), it was significantly decreased in the epidural group at T15, T30, T45 and T60.

This results comes with agreement with the study done by Deschamps et al who evaluated the correlation between the progression of somatosensory blockade and changes in autonomic outflow following the onset of labour epidural analgesia by using 0.125% bupivacaine with 50 microg of fentanyl (total volume 20 mL) in the epidural, and concluded that blood pressure variability decreased with the progression of both sympathetic and somatosensory block following epidural anesthesia [17].

In the contrast to our results, the study done by Fratelli et al who studied the effects if epidural analgesia on the uterine doppler in labor and concluded that the (MAP) is not affected between epidural and control group [18]. This different can be explained by they used ropivacaine at a lower concentration, and sensory analgesia reached the T10 level which according to the ASA guidelines corresponds to a lower level and less profound spinal block [19] in contrast to our study where bupivacaine has more motor block effect.

As regards the uterine artery pustule index (UtA -PI) during uterine relaxation and contraction at base line , 30, 60, 90, and 120 minutes, there was significant increase in (UtA -PI) only at 30 and 60 during contractions, these results means that the impedance in the uterine artery increased and so the blood supply to the fetus was decreased.

Stephen et al reported an increase in PI of the uterine arteries after epidural anesthesia with lidocaine, epinephrine, and fentanyl [20].

This result comes also consistent with the study done by Chen et al, who studied the effects of continuous epidural infusion in normal labour and demonstrated that the indices of the maternal uterine artery were significantly increased after epidural infusion in normal labour without the effect on umbilical or cerebral fetal indices [21]. In the study done by Fratelli et al who studied the effects if epidural analgesia on the uterine doppler in labor they found that UtA-PI measured during contraction was significantly increased 30 min after administration of bolus ropivacaine 0.1% in women laboring with epidural analgesia when compared with PI measured in women labouring without analgesia. This increase in uterine arterial impedance, however, was not associated with neonatal acidosis or low Apgar scores at birth. But the increase in UtA-PI did not persist 90 min after the beginning of analgesia, when the action of ropivacaine would be diminished. And they suggested that maternal hypotension related to epidural analgesia is associated with an increase in the Doppler indices for the uterine arteries [22]. The increased impedance measured during uterine contraction might be related to an insufficient increase in preload because of epidural anesthesia-induced sympathetic block and vasodilation [22].

Concerning the uterine artery (UtA -PI) during contraction and relaxation and the neonatal Apgar score, there was no significant difference between the studied groups. These results is supported by the study done Lindblad et al. and found no significant changes in resistance in the umbilical vein or fetal aorta associated with uncomplicated epidural anesthesia [23].

Hughes et al, concluded that effective epidural anesthesia did not have a significant impact on Doppler flow characteristics of either the maternal or fetal umbilical vasculature, despite lowered maternal blood pressure and heart rate [24].

Morrow et al, also reported that epidural anesthesia had neither a beneficial nor detrimental effect on uterine or umbilical blood velocity in uncomplicated pregnancy [25].

Also the study done by Chen et al, who studied the effects of continuous epidural infusion on velocimetric indices of the fetal umbilical and middle cerebral artery and concluded that there was no significant difference in the fetal umbilical or cerebral indices and also in the neonatal [26].

And also the study done by Valentin et al, who compared uterine artery, umbilical, and fetal cerebral Doppler velocities after epidural analgesia during labor and concluded that uterine artery velocities, but neither umbilical nor fetal cerebral Doppler velocities, were decreased significantly at 20 minutes and 1 hour after epidural analgesia [27].

15, 30, 45, 60 minutes and the placental blood flow at 30, 60 minutes after induction only during uterine contractions but these effects not affect the umbilical blood flow, labor outcomes and neonatal outcomes.


Gerhardt MA, Gunka VB, Miller RJ. Hemodynamic Stability During Labor and Delivery.
Liu EHC, Sia ATH. Rates of caesarean section and instrumental vaginal delivery in nulliparous women after low concentration epidural infusions or opioid analgesia: systematic review. BMJ. 2004;328:1410-5.