The management of labour using continuous lumbar epidural analgesia with 0.2% ropivacaine in a parturient with traumatic brain injury

EDITOR:
Though rare, intracranial haemorrhage during pregnancy can lead to maternal and fetal mortality and serious neurological morbidity. At present, most published reports focus on the anaesthetic management for parturients with ruptured intracranial aneurysms or arteriovenous malformations. Other causes of intracranial haemorrhage during pregnancy include eclampsia, systemic coagulopathy, intracranial tumours and trauma. We present a case of a pregnant patient with traumatic brain injury whose labour and delivery was managed successfully with continuous lumbar epidural analgesia with 0.2% ropivacaine.

A 41-yr-old gravida 5, para 4 at 38 week gestation was sent to our hospital after a motor vehicle accident. The patient’s past medical history was unremarkable. She had facial lacerations and isolated head injury. On arrival in the emergency department, the patient was drowsy, and complained of nausea, vomiting and frontal headache. The computerized tomography (CT) scan revealed mild diffuse axonal injury with bifrontal traumatic subarachnoid haemorrhage and some contusion haemorrhage in the left temporal lobe. She was admitted to the surgical intensive care unit (ICU) for observation and conservative treatment. In the ICU, she was intermittently disoriented to time and to place, without further neurological deterioration. Two days after admission, she began to feel uterine contractions, each of which was accompanied by a worsening of the frontal headache, with nausea and vomiting. The patient was keen to have a vaginal delivery and to be awake during the delivery despite having been informed of the associated risks. The obstetrician, neurosurgeon and anaesthesiologist agreed to this procedure with continuous epidural analgesia. Epidural analgesia was performed when contractions were well established and the cervix was dilated to 3 cm. With the patient in the left lateral decubitus position, epidural puncture was performed with an 18-G Tuohy needle at the L3–L4 using the technique of loss of resistance to air. A 20-G nylon catheter was advanced 4 cm beyond the tip of the Tuohy needle in the cephalad direction. After an uneventful test dose, ropivacaine 0.2% 10 mL was injected slowly. This soon resulted in good analgesia, and the patient stated that the severity of her headaches during uterine contractions had subsided. Epidural analgesia was maintained with continuous infusion of 0.2% ropivacaine at a rate of 5 mL h⁻¹. During labour, the patient’s blood pressure (BP) varied between 110/66 and 102/60 and her heart rate (HR) remained stable between 70 and 80 beats min⁻¹. Fetal HR was also monitored and remained stable between 120 and 160 beats min⁻¹ throughout. She was satisfied with labour pain control and reported no motor block. The second stage of labour proceeded smoothly and lasted 30 min. Maternal pushing efforts were effective and neither forceps nor vacuum assistance was required. Four hours after commencement of epidural analgesia she successfully delivered a healthy 3525 g male infant without any complication. The patient’s neurological status remained stable during the following days. Although she still had occasional headaches, she remained oriented and was discharged 1 week after her accident.

Epidural block is generally considered to be contraindicated in patients with a head injury and elevated intracranial pressure due to the risk of brain stem herniation if dural tap should occur. On the other hand, the management of obstetric analgesia and anaesthesia in patients with elevated intracranial pressure is controversial, since none of the options is without risk. Further increase in intracranial pressure and cerebral oedema during induction and emergence, pulmonary aspiration of gastric contents, failed endotracheal intubation and neonatal depression are
potential problems during general anaesthesia for parturients.

In pregnancies complicated by intracranial haemorrhage, maternal and fetal outcomes are similar after Caesarean and vaginal delivery [1]. The decision for surgical therapy of intracranial haemorrhage during pregnancy should be based upon neurosurgical principles, whereas the method of delivery should be based upon obstetric considerations. Anaesthetists should be familiar with the benefits and risks of all the different management strategies.

Galbert and Marx [2] noted that in parturient patients, extradural and cerebrospinal fluid pressure both increased during uterine contractions and that this could be mitigated by left uterine displacement and adequate analgesia, implying that the pressure elevation was associated not only with inferior vena cava compression, but also with pain and movement secondary to uterine contractions. Goroszeniuk and colleagues [3] described a pregnant patient with a malignant cerebral tumour who presented with increased severity of headache and fluctuation in her level of consciousness during uterine contractions. Patients with intracranial pathology such as neoplasm or haemorrhage may have reduced cerebral compliance and thus suffer greater increases in intracranial pressures. If delivery is to be per vaginam, then the objective of anaesthetic management will be to provide pain-free labour to lessen the impact of these acute physiological disturbances.

Hilt and colleagues directly measured intracranial pressures in two patients with head injuries [4]. They noted that intracranial pressure increased significantly after epidural injection of local anaesthetic or saline. Such increases can be attributed to dural compression and cephalad displacement of cerebrospinal fluid. When the intracranial compliance is poor, intracranial pressure will rise significantly. They concluded that epidural anaesthesia should not be used in patients with severe intracranial hypertension or obvious space-occupying lesions. A very slow injection rate should be used in patients with reduced intracranial compliance requiring epidural injection. Murthy and colleagues [5] described a parturient with reduced intracranial compliance who experienced transient severe frontal headache as a symptom of increased intracranial pressure during each epidural top-up injection during labour. This patient finally received Caesarean section and continuous epidural infusion for postoperative analgesia and no more headaches were reported during this infusion.

Our patient, who had traumatic brain injury and signs of increased intracranial pressure requested vaginal delivery. Since adequate pain relief during labour reduces the risk to the mother and, in our opinion, epidural analgesia is the most reliable technique for providing pain-free labour, we decided to perform the technique using great caution. The loading dose was given as slowly as possible and analgesia was maintained with continuous epidural infusion. This resulted in satisfactory relief of labour pains and symptoms of increased intracranial pressure.

Ropivacaine is a well-tolerated local anaesthetic for epidural anaesthesia and analgesia. Its analgesic efficacy is broadly similar to that of bupivacaine but with less motor block than bupivacaine. It is also a preferred option because of lower neurologic and cardiac toxicity. Used during labour and delivery, ropivacaine and bupivacaine provide equivalent analgesia but there is a higher rate of spontaneous deliveries with ropivacaine. Beilin and colleagues [6] recommended that if ropivacaine is used as the sole local anaesthetic for epidural anaesthesia in labour the minimal concentration should be 0.2%. Cascio and colleagues [7] showed that 0.2% ropivacaine produced satisfactory labour analgesia at epidural infusion rates between 4 and 10 mLh\(^{-1}\).

In order to not aggravate our patient’s nausea and vomiting, which might confound our clinical evaluation of her neurological situation, we decided to avoid fentanyl and used epidural ropivacaine only, although fentanyl has been reported to reduce local anaesthetic requirements. The slow bolus injection of ropivacaine 0.2% 10 mL followed by a continuous infusion at 5 mLh\(^{-1}\) allowed a painless vaginal delivery. Most importantly, no maternal and fetal complications occurred.

In conclusion, as in many complicated situations, the advantages and disadvantages of anaesthetic techniques for head-injured patients in labour should be carefully weighed against each other. It is our opinion that continuous lumbar epidural analgesia with 0.2% ropivacaine as described here is a sound alternative.

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References

3. Goroszeniuk T, Howard RS, Wright JT. The management of labour using continuous lumbar epidural analgesia in a

The ProSeal™ laryngeal mask airway may prevent of hiccups-related aspiration

EDITOR:
Hiccup is frequently triggered by the induction agent, face mask ventilation or airway device insertion and is notoriously difficult to treat with systematically applied drugs. It is associated with lower oesophageal reflux with one author noting a frequency as high as 40% [1]. The risk of hiccup-related aspiration is unknown, although in principle it could be reduced by use of an airway device that isolates the respiratory tract from the gastrointestinal tract. Perhaps patients who develop hiccup should be paralyzed and intubated, but non-depolarizing muscle relaxants take 2–3 min to take effect, potentially leaving the patient at risk during this period. The ProSeal™ laryngeal mask airway (PLMA) is a relatively new laryngeal mask device that isolates the respiratory tract from the gastrointestinal tract, has a drain tube for venting-regurgitated fluid and does not require muscle relaxants for insertion [2]. We describe three cases where the PLMA may have prevented hiccup-related aspiration of gastric contents.

Case 1
A 53-yr-old, 61 kg female presented for a knee arthroscopy. She had no history of gastro-oesophageal reflux, took no medication and had been fasted for 8 h. The airway management plan was to use a size 4 classic laryngeal mask airway (LMA). Following induction of anaesthesia with propofol 180 mg and commencement of face mask ventilation, she developed hiccups. A size 4 PLMA was easily inserted using the digital technique and while the cuff was being inflated approximately 30 mL of bile-stained fluid was vented from the drain tube. Slight pressure was applied along the airway tube to increase the efficacy of the seal with the upper oesophagus. A gastric tube was inserted via the drain tube and 20 mL of bile-stained fluid was suctioned from the stomach. The PLMA was fixed to the face with tape. Fibreoptic inspection of the pharyngolarynx and proximal trachea revealed no evidence of pharyngeal regurgitation or aspiration, respectively. The hiccups were refractory to treatment with atropine, but ceased spontaneously after 10 min. The case was completed uneventfully with the PLMA.

Case 2
A 58-yr-old, 128 kg male presented for a laparoscopic cholecystectomy. He had a history of twice weekly gastro-oesophageal reflux, which was controlled by omeprazole 40 mg, and he had been fasted for 6 h. The airway management plan was to perform laryngoscope-guided tracheal intubation. Following induction of anaesthesia with alfentanil 1.5 mg and propofol 300 mg and commencement of face mask ventilation, he developed hiccups. A size 5 PLMA was easily inserted using the digital technique, the cuff inflated with 20 mL air, ventilation established and the PLMA fixed to the face. Rocuronium 50 mg was administered. However, before the onset of muscle relaxation, approximately 20 mL of clear fluid was suctioned from the drain tube. A gastric tube was inserted and 10 mL of clear fluid was suctioned from the stomach. Fibreoptic inspection of the pharyngolarynx and proximal trachea revealed no evidence of pharyngeal regurgitation or aspiration, respectively. The oropharyngeal leak pressure was greater than 50 cmH₂O and the case was completed uneventfully with the PLMA.

Case 3
A 49-yr-old, 94 kg male presented for a laminectomy. He had no history of gastro-oesophageal reflux, took no medication and had been fasted for 6 h. The airway management plan was to use a size 5 PLMA. Following induction of anaesthesia with alfentanil...
1 mg and propofol 250 mg the PLMA was easily inserted with the patient in the supine position using a laryngoscope-guided, gum elastic bougie-guided technique; however, hiccupping was triggered by cuff inflation. Slight pressure was applied along the airway tube as the PLMA was fixed into position. Just as a gastric tube was about to be inserted, 15 mL of bile-stained fluid was vented from the drain tube. Gastric tube placement was rapidly completed and 100 mL of bile-stained fluid was removed from the stomach. Hiccups were refractory to atropine, but responded to metoclopramide 10 mg. Fibreoptic inspection of the pharyngolarynx and proximal trachea revealed no evidence of pharyngeal regurgitation or aspiration, respectively. The case was completed uneventfully with the PLMA.

These cases illustrate that the PLMA can prevent aspiration of regurgitated gastric contents associated with hiccup. One of the main advantages of the PLMA over the classic LMA is that it provides better protection against regurgitation, as it has a drain tube, forms a better seal with the upper oesophageal sphincter and malposition is more easily detected [2]. There is evidence from clinical studies that the correctly positioned PLMA isolates the gastrointestinal tract from the respiratory tract, and evidence from a cadaver study that the efficacy of seal with the oesophagus is 50–80 cmH₂O [2].

In Cases 1 and 2, the PLMA was inserted after the onset of hiccup to provide airway protection. The PLMA offers advantages over laryngoscope-guided tracheal intubation in this situation, as insertion can take place without waiting for muscle relaxation. A possible disadvantage is that the PLMA might increase the severity of hiccup-related reflux. However, once the distal cuff is correctly positioned it should protect the airway, as in the current cases. If necessary, the patient can be intubated once hiccup has subsided and the stomach emptied with a gastric tube. We elected not to intubate any of our patients, as the PLMA was functioning adequately. Also, there is always some risk when exchanging one airway device for another. In principle, other extraglottic airway devices with drain tubes, such as the laryngeal tube suction and the Elisha airway, might also be useful in this situation.

In Case 3, the PLMA was inserted before the onset of hiccup, which was triggered by cuff inflation. The overall incidence of hiccup with the classic LMA is about 1.4% and it is more common in the placement phase than the maintenance or emergence phases. Stretching pharyngeal mechanoreceptors in cats and upper oesophageal receptors in human beings causes hiccup and is the probable mechanism of hiccup with extraglottic devices. Hiccup may be associated with transient relaxation of the lower oesophageal sphincter after LMA insertion. Skinner and colleagues [3], in a 1998 study of 40 adults undergoing gynaecological laparoscopy with the LMA, noted that lower oesophageal reflux occurred in the only patient in whom hiccup occurred. Roberts and Goodman [4] reported a similar finding for intubated patients.

Borromeo and colleagues [5] reported a similar case of regurgitation without aspiration in a 40-yr-old female in whom hiccup commenced after PLMA insertion. The authors hypothesized that during hiccup fluid accumulated in the lower esophagus until sufficient pressure built up to allow sudden escape through the drain.

In the first and third cases, we applied force along the shaft of the PLMA to increase the efficacy of seal and to ensure that there would be no displacement of the distal cuff from the hypopharynx prior to fixation. Stix and colleagues [6], in 2002, noted that securing the PLMA with moderate longitudinal force along the airway tube improved the seal with the hypopharynx, but provided no supporting data.

Pharmacological treatment for hiccup is based on empirical findings rather than being ‘evidence-based’. Kanaya and colleagues [7] reported the successful use of atropine to treat hiccups in three patients after LMA insertion. In contrast, we found that hiccup was resistant to atropine. We also found that hiccup responded to metoclopramide in one case, although this may have been co-incidental.

We conclude that the PLMA can protect the airway from regurgitation associated with hiccups. The PLMA may be a useful alternative to laryngoscope-guided tracheal intubation in preventing hiccup-related aspiration triggered by the induction agent or face mask ventilation.

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References
Prediction of difficult mask ventilation

EDITOR:
Airway difficulties continue to pose problems for the attending anaesthesiologists and emergency physicians due to risk of hypoxic damage to brain and other vital organs. Most authors have concentrated on prediction of difficult tracheal intubation, but very little has been done to predict difficult mask ventilation. Thus, we undertook a prospective study to find the factors leading to difficult mask ventilation and to prepare a simple prediction criterion.

After approval by the Hospital Ethics Committee, and informed consent, 500 adult patients irrespective of ASA grade requiring general anaesthesia were enrolled in the study. Patients with respiratory disease or contraindication for prolonged mask ventilation were excluded. Biometric indices and airway were assessed on preoperative visit. The mandibular protrusion test was assessed as the ability to protrude the lower jaw in front of the upper jaw. A subjective opinion for assessment of anticipated difficult mask ventilation by a consultant anaesthesiologist was also noted. All patients had a standard premedication and induction of anaesthesia. Monitoring comprised heart rate, ECG, SPO2 and blood pressure. After pre-oxygenation, anaesthesia was induced with a sleep dose of thiopentone. Succinylcholine 1.5 mg kg⁻¹ was administered intravenously for neuromuscular blockade. The lungs were ventilated through a mask, with or without a Guedel’s oropharyngeal airway using a Magill’s circuit with 100% oxygen and a flow of 10 L min⁻¹ for 3 min. The anaesthesiologist rated the mask ventilation as difficult when the difficulty was considered clinically relevant and could have resulted in potential problems if mask ventilation has to be continued for a prolonged period. Failure to ventilate with the mask was recorded whenever there was inability to ventilate and maintain SPO₂ >90% by an anaesthesiologist with the use of emergency oxygen flush and when assistance or an alternative means (laryngeal mask, tracheal intubation or cricothyroidotomy) to ventilate the lungs was required. Then laryngoscopy and intubation were performed with a Macintosh laryngoscope and intubation was considered difficult whenever more than two attempts to intubate the trachea were required by an experienced anaesthesiologist or there was a laryngoscopic view of grade III or IV on Cormack and Lehane classification.

Data was analysed using univariate comparison for various potential factors causing difficult mask ventilation. The factors with higher significance were subjected to multivariate analysis. Diagnostic values of different variables for predicting difficult mask ventilation were calculated. In addition, a Receiver Operator Characteristic curve was used to judge the discrimination ability of various clues to predict difficult mask ventilation.

Difficult mask ventilation was found in 65 patients (13%). In one patient out of these 65, the anaesthesiologist failed to ventilate the lungs with the use of airway adjuncts and assistance however tracheal intubation was successful. It was found that weight, body mass index (BMI), age, Mallampati Class, macroglossia, lack of teeth, beard, waist : hip ratio, mandibular protrusion test, short neck, double chin and snoring history were statistically significant variables associated with difficult mask ventilation (Table 1). In contrast gender, mouth opening and thyromental distance did not gain statistical significance. On multivariate analysis seven variables – weight, BMI, age, Mallampati Class, mandibular protrusion test, short neck and double chin with high Odds Ratios (ranging from 14.74 to 4.18) were found to be independent risk factor for difficult mask ventilation. It was also found that difficult intubation occurred 37 times more frequently in patients with difficult mask ventilation (P = 0.001). The diagnostic value of different
variables in combination for prediction of difficult mask ventilation is shown in Table 2.

We found a strikingly high incidence of difficult mask ventilation. In 1989, Benumof reported an incidence of completely failed mask ventilation and tracheal intubation in 0.001–0.02% of cases [1]. Langeron in his pioneering prospective work found overall an incidence of difficult mask ventilation of 5% [2]. The experience of the anaesthetist might have contributed to bias as most of our anaesthetists were in the 3rd year of their residency. Another factor causing this difference is that the previous results had been derived from incidental reports and analysis of hospital records which often miss potentially difficult mask ventilation cases. However, the contribution of the population sample and ethnic variation to difficult mask ventilation cannot be ignored. Our population sample included 17.6% bearded Sikh males. Many previous authors have explored the relation of obesity or obesity related objective indices with difficulties in airway problems and their management. A higher BMI (>26 kg m\(^{-2}\)) poses difficulty in ventilation due to the increased force required to ventilate a large or heavy chest [3]. Young and Willet found that 60–90% of patients with obstructive sleep apnoea had a BMI >29 kg m\(^{-2}\) and concluded that indices of obesity strongly correlated with severity of obstructive sleep apnoea. Haemoglobin saturation has been shown to decrease more rapidly during apnoea in patients with a BMI >40 kg m\(^{-2}\) [4,5]. Age has been found to be closely associated with an increased pharyngeal resistance to airflow (from choanae to epiglottis) in men [2,6]. Many of the factors present in univariate analysis indicated a high likelihood of difficult mask ventilation but had a poor false negative predictive value in multivariate analysis. Difficult mask ventilation is a multifactorial problem. A number of fixed and variable patient factors play a role in causing difficult mask ventilation in addition to the anaesthetist's experience and competence, type of mask, etc.

We found the mandibular protrusion test to be an important variable strongly associated with difficult mask ventilation. On calculating the diagnostic value of a combination of factors on the receiver operating characteristics curve it was found that combining the two factors of BMI >26 kg m\(^{-2}\) and mandibular protrusion reliably gave the best overall prediction of difficult mask ventilation. However, when compared with subjective assessment, it was found that subjective assessment had a better sensitivity, specificity and overall predictive value.

Our study has limitations including a small sample size, experience bias and its design to comment upon the difficulties faced during prolonged mask ventilation. Mask ventilation becomes difficult with passage of time. Operator fatigue and gastric insufflation of gases associated with difficult mask ventilation compound the existing problem. While problems with airway maintenance may be obviated during anaesthesia by the use of airway adjuncts or aids, identification of risk and caution are keys to management and the airway should be secured before anaesthesia where doubt exists. If tracheal intubation is needed, spontaneous breathing until intubation is an important principle. Every anaesthetist should have in mind a plan for failed intubation or worse, failed ventilation.

<table>
<thead>
<tr>
<th>Variable</th>
<th>No DMV (435)</th>
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<th>P-value</th>
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<tr>
<td>Height (cm)</td>
<td>161.5 ± 8.6</td>
<td>163.3 ± 11.3</td>
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<td>Gender (male)</td>
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<td>41 (63.1)</td>
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<td>Mallampati Class</td>
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<tr>
<td>I</td>
<td>316 (72.6)</td>
<td>17 (26.2)</td>
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<tr>
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<table>
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<td>3. 2 + Short neck</td>
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<td>4. 3 + Weight</td>
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<td>7. Anticipated DMV (subjective assessment)</td>
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<td>95.0</td>
<td>70.0</td>
<td>96.0</td>
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DMV: difficult mask ventilation; PPV: positive predictive value; NPV: negative predictive value.

<table>
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<tr>
<th>Table 1.</th>
<th>Comparison of patients (n = 500) with or without DMV.</th>
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DMV: difficult mask ventilation; PPV: positive predictive value; NPV: negative predictive value.

In conclusion, we found the incidence of difficult mask ventilation to be higher than previously reported. Difficult mask ventilation can be predicted quickly and reliably using BMI and the mandibular protrusion test. As there is a strong correlation between difficult mask ventilation and difficult tracheal intubation, we recommend formulating a departmental policy to manage airway in expected difficult mask ventilation candidates and that these subjects should be either intubated awake using fiberoptic assisted tracheal intubation or an alternative means of ventilation such as a supraglottic device be available to prevent untoward accidents.

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Free plasma levels of bupivacaine and ropivacaine when used for caudal block in children

Both ropivacaine and bupivacaine are widely used in regional anaesthesia. The effective sensory block associated with reduced motor block and less cardiac and neurologically toxic effects are well-known properties of ropivacaine in adults. However, conflicting pharmacokinetic reports exist in children [1,2]. We therefore decided to examine the free plasma levels of ropivacaine and bupivacaine in children during our daily practice of outpatient hypoplasias or groin surgery under caudal block. Equivalent dose and concentrations of both local anaesthetics were used.

Following institutional ethics committee approval and parental informed consent, 38 children ASA I aged between 10 months and 8 yr undergoing hypoplasias or groin surgery in an ambulatory setting were included in this study. Children who had anatomic malformation of the spine, a history of convulsions or neuromuscular disease, skin infection of the caudal area, coagulopathy, renal or hepatic impairment, or delayed development were excluded. The children were not premedicated and were fasted for 2 h before surgery. After applying standard monitoring, general anaesthesia was induced using an intravenous (i.v.) technique, the trachea was intubated and each child placed in the left lateral decubitus position. The caudal epidural space was approached using an aseptic technique with a caudal needle (Braun Epidural, 22-G 35 mm long) and identified by use of a saline filled syringe and the loss of resistance method. After negative aspiration of blood and cerebrospinal fluid, children were randomly allocated to receive 0.5 mL kg\(^{-1}\) of a 0.25% solution (1.25 mg kg\(^{-1}\)) of either bupivacaine \(n = 17\) (Marcaine Astra Zeneca, Eczacıbaşı, Turkey) or ropivacaine \(n = 21\) (Naropin, Astra, Sweden). All blocks were performed by the attending paediatric anaesthesiologist or the senior resident. To detect and avoid an i.v. or subarachnoidal injection, the needle was repeatedly aspirated and local anaesthetic injected in increments while the electrocardiogram (ECG) was closely observed. Blood pressure (BP) and heart rate (HR) were recorded just before and after surgical incision and every 5 min thereafter until the end of anaesthesia. Venous blood samples (1 mL) were withdrawn from a peripheral i.v. catheter 1 and 2 h after the insertion of the block. The i.v. catheter was flushed with 1 mL heparinized saline. Blood samples which were collected in ethylene diamine tetraacetic acid (EDTA) containing glass tubes were subsequently separated by centrifugation and the plasma stored at \(-20^\circ C\) until analysed. Free bupivacaine and ropivacaine levels were determined with gas chromatography and mass spectrometry by

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using a Hewlett Packard 6890 and 5973, GC-MS system (Hewlett Packard, Palo Alto, CA, USA). The gas chromatograph was fitted with an HP 5 (30 m × 0.25 mm × 0.25 µm thickness) film. Data was analysed by t-test and is expressed as mean ± SD (range). P < 0.05 was considered statistically significant.

The distribution of age and the gender was similar between groups (Table 1). There were no changes in ECG traces throughout the operations. HR and BPs were stable unless there was traction on the hernial sac. Adequate analgesia was achieved during the operation and patients awoke free of pain. All of the patients were able to raise their lower limbs. There was no evidence of systemic local anaesthetic toxicity in any patient. In the bupivacaine group, bupivacaine concentrations were 46.8 ± 17.1 (27–98) ng mL⁻¹ and 23.8 ± 8.1 (13–46) ng mL⁻¹ at 1 and 2 h, respectively. In the ropivacaine group concentrations were 61.2 ± 8.2 (47–75) ng mL⁻¹ and 49.5 ± 6.9 (39–63) ng mL⁻¹ at 1 and 2 h, respectively. The difference between the groups was statistically significant.

It has been stated in the literature that central nervous system and cardiovascular system toxicity appear when free bupivacaine concentration is >0.25 µg mL⁻¹ (250 ng mL⁻¹) and ropivacaine concentration is >0.15–0.6 µg mL⁻¹ (150–600 ng mL⁻¹) [3–5]. None of the patients reached toxic levels. Several authors have reported that the maximum concentration occurs at around 60 min for ropivacaine in infants and young children after a single bolus dose of caudal epidural ropivacaine [2,6,7]. The duration of surgery for ambulatory procedures such as groin surgery is around 60 min. Pharmacokinetic studies in children have noted that bupivacaine concentration peaks at about 20 min which is generally during the operation [1,2]. Similar to previous studies, the free ropivacaine concentration in our study was significantly lower than 0.6 µg mL⁻¹ at the first hour [1]. When most of the patients were leaving the recovery room the free bupivacaine concentrations were 23.8 ng mL⁻¹, a very safe concentration for toxicity.

We conclude that when using caudal 1.25 mg kg⁻¹ ropivacaine or bupivacaine at a concentration of 0.25% the free plasma concentrations do not reach levels of potential toxicity.

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Ex utero intrapartum procedure for delivery of a fetus with a large cervical mass

EDITOR:
The ex utero intrapartum treatment (EXIT) procedure is used to maintain utero-placental flow and fetal gas exchange allowing the management of a potentially obstructed fetal airway. The EXIT procedure was first proposed for the management of congenital diaphragmatic hernia but is now also being used when the fetal airway is compromised by cervical masses or congenital obstructions [1]. Adequate uterine relaxation during the anaesthetic is obtained by high concentrations of inhalational agents, if necessary supplemented by nitroglycerin or tocolytics [2]. We report a case of EXIT for a giant fetal cervical mass.

A 36-year-old gravida 2, para 1, was admitted in week 38 due to the presence of a giant fetal cervical mass. At 32 weeks of gestation, a right anterolateral fetal cervical mass of 8-cm diameter had been diagnosed by ultrasonography. Magnetic resonance imaging performed which suggested a mass compatible with a cystic lymphangiomma associated with airway deviation. A multidisciplinary team was assembled for management using the EXIT procedure.

The patient received midazolam 2 mg, omeprazole 40 mg and metoclopramide 10 mg intravenously (i.v.) as premedication. In addition to standard monitoring, maternal direct blood pressure was also established. After left uterine displacement and 100% oxygen administration for 5 min, general anaesthesia was induced by a rapid-sequence technique with thiopental 450 mg and succinylcholine 75 mg followed by endotracheal intubation. Anaesthesia was maintained with 50% nitrous oxide and 2–3% isoflurane in oxygen, fentanyl (2 µg kg⁻¹) and vecuronium (0.1 mg kg⁻¹). Ephedrine 5 mg boluses were administered i.v. to maintain maternal mean arterial pressure at >65 mmHg.

Head delivery occurred 26 min after induction. A uterine infusion with lactate Ringer’s solution was begun to preserve uterine volume and prevent placental separation. While the feto-placental circulation was preserved, orotracheal intubation of the fetus was attempted by direct laryngoscopy and also by rigid bronchoscopy but was unsuccessful. Tracheostomy was impossible due to the enormous cervical mass and gross distortion of the anatomy. A paediatric surgery team then performed partial resection of the cervical mass. The left arm of the fetus was then delivered, a sterile pulse oximetry probe placed and continuous electrocardiogram recorded. Atropine 0.05 mg and fentanyl 30 µg were administered intra-muscularly to the fetus. After further surgical resection of the cervical mass, orotracheal intubation was achieved and confirmed by rigid bronchoscopy.

Fetal haemodynamics remained stable throughout the procedure with pulse oximetry values between 82% and 87% and heart rate 130–160 beats min⁻¹. No extra tocolytics or nitroglycerin was necessary to reinforce uterine relaxation.

Sixty-eight minutes elapsed from maternal anaesthesia induction to umbilical cord clamping. At the time of clamping, umbilical artery pH was 7.26. The umbilical vessels were cannulated and the newborn was transferred to an adjacent operating room to complete surgical resection under general anaesthesia.

After delivery and cord clamping, isoflurane was discontinued and oxytocin 5 U was given i.v. followed by a continuous infusion (20 U of oxytocin per litre) and anaesthesia maintained using nitrous oxide 70% and oxygen 30%. Uterine tone improved and maternal bleeding was minimal. Neuromuscular blockade was reversed by neostigmine 2.5 mg and atropine 1 mg. The patient’s preoperative haematocrit had decreased by 5%. She was discharged on the fourth day. The newborn was admitted to the intensive care unit and underwent further surgery to remove sublingual cysts on the thirteenth day.

Discussion
Large fetal neck masses can cause a life-threatening situation after birth due to airway obstruction leading to asphyxia and secondary brain damage [3]. In this case, the airway deviation by the cervical mass observed on the scan predicted intubation difficulty and therefore the EXIT procedure was planned for week 38. Management by a multidisciplinary team was of paramount importance to optimize fetal outcome.

General anaesthesia is the best technique for the EXIT procedure because it allows the use of high concentrations of inhalational agents important not only for the maintenance of uterine relaxation but also for fetal anaesthesia. Uterine relaxation is crucial to prevent placental separation, to maintain placental perfusion and fetal oxygenation while securing the fetal airway. The uterine atony caused by high concentrations of halogenated agents markedly increases the risk of maternal haemorrhage. A hysterotomy stapling device and the administration of
oxytocin after clamping the umbilical cord minimizes bleeding. High doses of halogenated agents also induce maternal hypotension and consequently, fetal distress. Ephedrine is recommended for the prevention and treatment of maternal hypotension.

Excellent uterine relaxation was achieved with 2–3% isoflurane, the use of additional tocolytics being unnecessary. No uterine stapling device was necessary and haemodynamic stability was maintained with i.v. fluids and small doses of ephedrine. Blood loss was insignificant. The uterine infusion of warmed lactate Ringer’s solution maintains uterine temperature and normal amniotic fluid volume and prevents umbilical cord compression.

During the EXIT procedure, fetal anaesthesia is essentially provided by administering inhalational agents to the mother and, if needed, supplemented with opiates and muscle relaxants. Fetal oxygenation depends on the uterine and umbilical blood flow, as well as on the maternal arterial oxygen content. Hundred percent oxygen during hysterotomy has been used in previous EXIT case reports although in this case, 50% oxygen was used and no fetal hypoxia was detected during the fetal surgery [4].

Uteroplacental support was maintained for 46 min. During this period, orotracheal intubation was attempted and partial recession of the mass was performed. The fetal pH after birth was 7.26, which suggests that uteroplacental gas exchange was acceptable. In a review of 52 EXIT cases, the average time of placental support was 45 ± 25 min with a maximum of 150 min [5].

In conclusion, the EXIT procedure allowed safe delivery of a fetus with cervical anomalies that would have interfered with ventilation.

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