Neuraxial analgesia in labour – induction and maintenance

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Abstract

Since the introduction of epidurals for labour analgesia in 1946 it has become the gold standard on delivery units throughout the world. Controversy remains as to the effects of neuraxial block upon the fetus; however, it is now widely accepted that there are beneficial and not just detrimental effects. With the introduction of low-dose anaesthetic solutions the major cardiovascular effects and concerns with toxicity have become much less prominent and the lack of profound motor block associated with traditional dosing has resulted in greater maternal satisfaction, although not the mobile revolution which was once anticipated. As research continues to search for the ideal labour analgesia, newer technologies are evolving making epidurals ever safer, individualized and tailored to the modern women in the delivery suite, as they demand greater control and autonomy over their deliveries. No current method has been able to emulate these ideals, but in the mean time women can enjoy safe and effective analgesia with minimal risks to either themselves or their babies.

Keywords Adjuncts; combined spinal epidural; continuous spinal analgesia; epidural; labour analgesia; PCEA; smart pumps; test dose

Royal College of Anaesthetists CPD Matrix: 1D02, 2B01, 2B04

Learning objectives

After reading this article, you should:
- understand the different options available for neuraxial analgesia
- be aware of the common drugs and concentrations used within the UK
- understand the potential effects on both mother and fetus and their implications
- have some insight into the potential advancements of labour analgesia

Induction of analgesia

The ideal analgesia for labour would be easy to initiate and maintain, safe for both the mother and fetus, require little in the way of additional monitoring and be effective both in the early and late stages of labour. Currently no form of analgesia fulfils these ideal criteria; however, epidurals continue to represent the gold standard. Approximately 20% of labouring women in the United Kingdom (UK) receive epidural analgesia, 60% in the USA, representing upwards of 140,000 epidural procedures, with the vast majority of these receiving high-quality analgesia without complications.[1] There is considerable variation in the availability of epidural analgesia between hospitals in the same country ranging from unavailable to up to 40% in some units.[2]

Other forms of analgesia therefore remain popular such as nitrous oxide and transcutaneous electrical nerve stimulation in the early stages of labour and intramuscular opioids such as pethidine and diamorphine in the later stages. Other newer modalities have emerged which have complimented the place of epidurals such as combined spinal-epidural (CSE), spinal catheters and the increasingly popular remifentanil patient-controlled analgesia (PCA). However, none of these have replaced the role of a functional epidural and are more suited to specific situations as discussed below.

Epidural

Epidurals have been used in labouring women since 1946. Traditional epidural techniques have involved concentrations of at least 0.25% bupivacaine, but are associated with greatly increased rates of instrumental delivery and significant motor block which precludes mobilization. With low-dose (0.1%) and ultra low-dose (0.0625%) local anaesthetic (LA) solutions, the rate of instrumental and assisted delivery as well as other side effects is significantly decreased.[3] Lower concentrations (Table 1), are able to establish adequate labour analgesia within a satisfactory time scale without subsequent dense motor block, and this has been facilitated greatly by the introduction of epidural opioids.

Prior to induction it is essential practice to administer a test dose. Various forms of test dose have been advocated, though huge individual variation remains. Common examples are 5–10 ml of low-dose mixture or 3–4 ml of 2% lignocaine with or without epinephrine. This is routinely placed down the catheter once sited, rather than directly through the Tuohy needle. The purpose of this dose is to identify a potential intrathecal or intravascularly placed catheter; the use of low-dose mixture has the added benefit of expediting the onset of the block. Intrathecal placement would result in the rapid onset of sensory/motor block (sacral and ankle) with associated sympathetic blockade (hypotension). Intravascular placement may result in perioral tingling though with low-dose solutions this may be subtle. The addition of epinephrine is not common practice within the UK, but when used can result in tachycardia.

Combined spinal epidural (CSE)

CSE involves the initial placement of an intrathecal dose of either LA or opiate, or a combination. A common dose is 3–5 ml of

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Summary of typical local anaesthetic drugs and doses for epidural and combined spinal epidural

Drug	Induction dose	Intermittent top-ups	Infusion	Patient-controlled epidural analgesia
Epidural				
Bupivicaine 0.1% + fentanyl 2 μg/ml	10–20 ml in 10 ml divided doses	10–20 ml every 30–60 min	8–15 ml/h	Boluses 5–10 ml lockout 15–30 min
Bupivicaine 0.0625% + sufentanil 0.25 μg/ml	10–20 ml in 10 ml divided doses	10–20 ml every 30–60 min	8–15 ml/h	Boluses 5–10 ml lockout 15–30 min
Ropivacaine 0.2%	10–20 ml in 10 ml divided doses	6–10 ml every 60 min	6–10 ml/h	
Combined spinal epidural				
Spinal component – 2.5 mg bupivicaine ± 25 μg fentanyl	As above	As above	As above	
Spinal component – 2.5 ml epidural mixture (0.1% bupivicaine + 2 μg/ml fentanyl)	As above	As above	As above	

Table 1

low-dose epidural solution (0.125% bupivacaine with 2 μg/ml of fentanyl) although other options exist. This is either then followed by low-dose epidural top up (10–20 ml every 30–60 minutes) or infusion once the initial spinal component has begun to recede. CSE has some support within the UK with up to 5% of neuraxial labour analgesia being initiated by this means.[2] CSE was originally introduced in an attempt to reduce the adverse effects associated with traditional epidural dosing improving maternal mobility while providing a more rapid onset of analgesia (characteristically within 5–10 minutes) which could contribute to increased maternal satisfaction.[4] Traditional epidural doses have now largely been supplanted by low-dose techniques, with only 10% of units in 2009 still employing 0.25–0.5% concentrations[5] and thus the perceived benefits are no longer as apparent. A Cochrane review in 2012 stated that there appears to be little basis for offering CSE over low-dose epidurals in labour, with no difference in overall maternal satisfaction despite a slightly faster onset with CSE and less pruritis associated with low-dose mixtures.[6] CSE therefore still has a place where the rapid onset of analgesia is required in a severely distressed parturient. This can be achieved, however, without the addition of spinal opiate which does not improve the initial analgesia and, indeed, risks fetal bradycardia.

Continuous spinal analgesia (CSA)

Intentional placement of spinal catheters is not routinely performed in the UK due to the unacceptably high incidence of post-dural puncture headache (PDPH) and association with a higher risk of permanent neurological damage.[6] A 2007 OAA survey identified that CSA was used in only 6% of units, with all women being high-risk cases with a headache rate of 4.9%. However CSA may also be appropriate after accidental but confirmed dural puncture occurs. Under these circumstances the catheter should be clearly labelled to prevent confusion as to its position and this should be clearly documented in the notes. Any top ups should be done by an anaesthetist only, especially where spinal catheters are not routine. Top-ups can be done with 3–5 ml of low-dose solutions, or low-dose continuous infusion of up to 5 ml/h. It has been suggested that CSA may reduce the risk of post-dural puncture headache (PDPH) and subsequent requirement for blood patch as well as reducing the risk of additional dural puncture from attempted resiting, although currently evidence remains conflicted.[7,8]

Dural puncture epidural

Newer techniques have been proposed such as dural puncture epidural where the dural membrane is deliberately punctured with either a 25 or 27G spinal needle once the epidural space has been located. The epidural catheter is then threaded into the epidural space without intrathecal dosing. The epidural is then topped up as normal with the expectation that LA mixture traverses into the intrathecal space thereby increasing the quality of the analgesia obtained. This is generally only effective with a 25G needle thereby creating an increased headache risk and as such has not gained widespread popularity.

Maintenance of analgesia

Mothers have multidimensional expectations of labour analgesia, and the ideal would be seamless through all phases of labour and individualized while preserving maternal autonomy. A range of methods have been utilized to achieved these aims while maintaining adequate analgesia (Box 1), including intermittent boluses, continuous infusions, patient-controlled epidural analgesia (PCEA) and newer variations of these techniques. The attainment of this ideal has been greatly enhanced since the introduction of low-dose LA mixtures.

Intermittent boluses

This refers to the intermittent administration by anaesthetist or midwife of 10–20 ml low-dose LA every 30–60 minutes

Methods of maintenance of epidural labour analgesia

Intermittent bolusing — low-dose top-up
Continuous Infusions
Patient controlled epidural analgesia (PCEA)
Intermittent continuous infusions
Programmable intermittent epidural boluses (PIEB)
Smart pumps: Uses feedback from patient during labour to reprogram the pump according to their needs during labour.

Box 1

(see Table 1). These concentrations are inherently safer than traditional top-ups with better maternal satisfaction, less motor block and a reduced incidence of instrumental deliveries. They achieve a better initial block due to more uniform epidural spread, and have a lower total LA consumption compared to infusion alone. They do, however, require close monitoring of mother and fetus especially around the time of top-up. They also have the increased potential of infection due to repeatedly breaking into the epidural line.

Continuous infusions

With this technique, similar LA solutions (see Table 1) are infused into the epidural space at a rate of between 8 and 15 ml/h. Some advantage is gained through reducing the number of interventions required by the midwife in maintaining analgesia, and thus reducing the risk of introducing infection. However, there is a noted overall increase in LA consumption with continuous infusion, and thus an associated reduction in the ability to mobilize. This technique results in a reduction in the fetal effects noted around the time of top-ups, but still requires vigilance in monitoring, particularly for the onset of inadequate block as labour progresses.

PCEA and smart pumps

PCEA in principle has a background infusion (5 ml/h) with patient-initiated boluses (5 ml every 15–20 min) and appears to increase analgesia without an increase motor block. With conventional PCEA there is no ability to vary the basal rate but with computer-integrated PCEA, as labour progresses and pain escalates, the basal infusion would increase to lower the incidence of breakthrough pain. Initial observations demonstrate a higher maternal satisfaction, but no difference in LA consumption responding to the dynamic and progressive nature of labour pain. It does require a central monitoring system but allows for potential remote monitoring of patient demands and correlation with progress in labour. Automated intermittent boluses versus PCEA show a reduced hourly consumption, and prolonged time to first demand. Smart ambulatory pumps are also under investigation but remain largely a research tool at present.

Local anaesthetic drugs

The choice of LA for induction and maintenance remains largely down to personal choice and local policy. The most commonly used and widely available within the UK is bupivacaine; however, the non-racemic enantiomers of bupivacaine, ropivacaine and levobupivacaine present potential advantages, although there is little between then from a fetal perspective.[9] Bupivacaine itself provides extremely effective analgesia, though it leads to a dose-dependent motor block and has associated cardiovascular and neurological side effects when given in overdose. Lignocaine is unsuitable for prolonged labour analgesia due to the increased motor block, tachyphylaxis and cumulative toxicity.[9]

Levobupivacaine is the L-enantiomer and is roughly equipotent to bupivacaine with a minimum local anaesthetic concentration (MLAC) of 0.98 and exhibits less cardiotoxicity by binding less avidly to the myocardium. With the current low doses that are used, the potential for toxicity is perhaps less of an actual problem than anticipated. Its use with infusion is becoming increasingly common due its apparent greater safety profile but remains restrained by cost.

Ropivacaine is a long-acting amide S-enantiomer of the similarly named racemate with an equivalent potency of 0.75 to bupivacaine. Given this, at least some of the benefits observed such as lack of motor block and reduced rate of instrumental delivery can be partially though not wholly ascribed to this difference in potency, rather than an inherent difference in the LA itself.

Adjuncts to LA

Adjuncts are intended to have either additive or synergistic effects to the delivered LA, and various drugs have been assessed as to their usefulness (Box 2), although currently only a few are used with any great frequency.

Fentanyl has been the most extensively investigated and has enabled the use of low-dose and ultra low-dose concentrations of LA, thus reducing the effects of motor block experienced with traditional dosing, improving maternal satisfaction. The next most extensively studied is clonidine (α2-receptor agonist). Clonidine (75 μg) added to LA/opioid mixtures improves the quality of analgesia, reduces hourly LA consumption, increases the duration of initial epidural analgesia without significant side effects, and may provide rescue analgesia in a malfunctioning

List of potential local anaesthetic adjuvants

- Opioids: fentanyl, diamorphine, sufentanyl
- Adrenergic receptor agonists: clonidine, adrenaline, phenylephrine
- Cholinergics: neostigmine
- GABA agonists: midazolam, baclofen
- Magnesium
- NMDA antagonists: ketamine
- NSAIDs: ketorolac
- Steroids
- Somatostatin
- Adenosine
- Bicarbonate

Box 2

epidural. At larger doses, side effects are more frequent with hypotension, nausea, sedation and fetal heart rate effects. Epinephrine (100 μg), which may be used to speed the onset of block where a labour epidural is being topped up for operative delivery, is known to cause increased nausea and motor block. Neostigmine can provide additive analgesia when given epidurally though is known to cause prohibitive nausea and vomiting when given intrathecally. Other than opiates, no agent is in regular widespread use, and the basic premise advocated should be to, 'keep it simple, and keep it safe' while looking for clear advantages and benefits before adding drugs.

Maternal and fetal outcomes

It has long been know that a painful labour produces adverse changes in maternal physiology, which in turn has adverse fetal effects. This is through activation of the stress response which results in increased sympathoadrenal activity, incoordinate uterine action and reduced uteroplacental blood flow. This can be attenuated to some extent by neuraxial analgesia without attenuating the fetal stress response to labour, which in itself is beneficial, reducing overall maternal and fetal acidosis.[9] On the face of it neuraxial analgesia would seem ideal; however, there are well-documented short-term effects from drops in circulating maternal catecholamines resulting in loss of short-term variability, decelerations and major fetal bradycardias, and CSE itself is an independent predictor of uterine hypertonus. The clinical importance of these reports remains unclear, however the National Institute for Health and Care Excellence (NICE) recommends continuous CTG monitoring after each top up of 10 ml or more for at least 30 minutes.[10]

It is suggested that epidural anaesthesia increases the incidence of instrumental delivery. However, a recent Cochrane review has suggested that since 2005 this is no longer the case.[11] Epidural is associated with maternal pyrexia (temperature >38°C) rising at 0.1°C per hour (relative risk 3.34). Reasons for this are multifactorial and poorly understood though decreased sweating and an increased shivering in rooms with high ambient temperatures in patients who are often covered with blankets may to contribute. Altered thermoregulation with a combined antipyretic effect from IV opioids plus an exaggerated maternal non-infectious inflammatory response via proinflammatory cytokines may also have influence.[12] There appears to be no dose-related drug effect and length of time of epidural does not seem to influence the likelihood of occurrence, and so it may appear to be a trigger effect, and indeed there may be a subset of women who are primed to develop fever during labour. This often has greater implications for the fetus than mother, associated with poor Apgar scores, a higher rate of seizures and hypotonia on delivery,[9] though from a maternal perspective may lead to unnecessary investigations and inappropriate antibiotics.

In 2009 the Royal College of Anaesthetists published the results of the third national audit project looking at all forms of neuraxial block within the UK.[1] This confirmed that obstetric neuraxial block is safe and associated with less complications as compared to other patient populations receiving similar interventions, particularly major complications (1:161,550 pessimistic interpretation of permanent harm), though wrong route errors are notably higher.

Mobility is also a major issue surrounding maternal satisfaction and epidural use. Since the introduction of low-dose solutions, profound motor block has become less common and the concept of the 'mobile epidural' was established. Despite this, many units prevent mobilization due to the risk of falls as a result of minor degrees of motor block and loss of proprioception and hence maternal and midwife confidence. However, with newer dosing regimes and with mobile epidural smart pumps, this may become a much more frequent sight on delivery units in the future.

The future of neuraxial labour analgesia

Neuraxial labour analgesia may develop over the coming years through new and novel techniques for the placement of epidural catheters. Such devices already exist including the Episure™ and Epidrum™. By uncoupling the means of needle advancement from the means of epidural space detection they compliment operator skill and potentially reduce the incidence of complications such as accidental dural puncture. These devices may improve operator control over the needle, while also potentially enabling a combination of techniques with real-time ultrasound guidance. Pre-procedure ultrasound scanning itself is becoming more commonplace, and provides the operator with additional information such as midline position and an estimation of epidural depth leading to potential greater success, especially when faced with obese parturients although real-time ultrasound guided needle placement remains technically difficult. There is, however, a learning curve associated with ultrasound technique, and it is unclear from literature whether success rates with its use are superior to clinical skill alone. NICE suggests that it is safe, and may be helpful in achieving correct placement, but currently does not formally recommend its use.[13] Other technologies in research include needle-shaped ultrasound probes which directly visualize the needle tip position, and needles which detect the blood-lipid fraction content of the tissues it passes through, thereby distinguishing the epidural space from ligaments and vascular placement. Finally pharmacogenetics delivers the prospect of being able to target analgesia to an individual women's genome, resulting in better analgesia, fewer side effects, lower toxicity and alternative drug choices. ◆

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