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Conversion of labour epidural analgesia to surgical anaesthesia for emergency intrapartum Caesarean section

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Learning objectives

By reading this article you should be able to:

- Describe the risk factors associated with the failure of converting epidural analgesia for labour to anaesthesia for Caesarean section.
- Discuss the merits and limitations of the methods used to confirm the correct location of the epidural catheter and the techniques used to evaluate the adequacy of neuraxial blockade.
- Debate the advantages and disadvantages of the different drugs used in the epidural top-up solution.
- Explain the implications of the options for management after a failed epidural top-up.

Key points

- Conversion of epidural analgesia for labour to surgical anaesthesia and general anaesthesia for emergency Caesarean section can be attained in comparable decision-to-delivery times.
- The fastest onset of sensory blockade when converting the epidural is achieved using lidocaine 2% and adrenaline (epinephrine), with or without fentanyl.
- The addition of ropivacaine 0.75% to the epidural top-up solution reduces the need for supplementation during surgery.
- Loss of sensation to touch up to and including the T5 dermatome is required to prevent pain reliably during Caesarean section.
- Optimal management of a failed 'epidural top-up' is subject to debate and best practice guidelines are required.

Introduction

Between 2017 and 2018, more than 100,000 emergency Caesarean deliveries were carried out in England, 21% of which were performed with epidural anaesthesia alone.[1] If a Caesarean section is needed in a parturient with an existing labour epidural, it is common practice to convert or 'top-up' the epidural catheter, with the aim of initiating surgical anaesthesia by injecting more concentrated local anaesthetic (LA) solution, normally combined with a lipid-soluble opioid. Guidelines from the Royal College of Anaesthetists (RCoA) recommend that the decision-to-delivery interval for ≥90% of

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Table 1 Risk factors associated with the failure of conversion of epidural analgesia for labour to surgical anaesthesia for Caesarean section.[4] CSE, combined spinal–epidural; OR, odds ratio

Consistent factors
• Greater number of unscheduled epidural top-ups needed to maintain effective analgesia in labour (OR 3.2)
• Increased parturient reported pain in the 2 h before Caesarean section
• Management by a non-obstetric anaesthetist (OR 4.6)
• Urgency of the Caesarean section (OR 40.4)
Inconsistent factors
• Increased BMI or weight
• Cervical dilatation at the commencement of labour epidural analgesia
• Epidural rather than CSE for analgesia in labour
• Increasing duration of epidural analgesia

Categories 1 and 2 Caesarean sections should be ≤30 and 75 min, respectively.[2]

Successful neuraxial anaesthesia conversion is a useful measure of quality of care, indicating the prior presence of functional labour epidural analgesia and limiting the use of general anaesthesia in obstetrics. In an effort to raise the clinical standard, guidelines from the RCoA state that the rate of conversion from neuraxial to general anaesthesia for Category 1 and Categories 1–3 Caesarean section overall should be <15% and 5%, respectively.[2]

In this article, we review the anaesthetic principles and practice associated with the effective and safe conversion of labour epidural analgesia to surgical anaesthesia for emergency intrapartum Caesarean section.

Assessment of a labour epidural for conversion to surgical anaesthesia

Conversion of an existing labour epidural for an emergency Caesarean section can fail, the incidence of which has been reported to range between 0% and 21%.[3] Hence, careful assessment of the function of the labour epidural is needed to be able to make an appropriate decision about whether or not to top it up.

Numerous factors are associated with the failed conversion of an existing labour epidural (Table 1).[4] Breakthrough pain in labour could be a marker of a poorly functioning epidural or may signify dysfunctional labour. However, in a retrospective study, many epidurals that had required unscheduled boluses in labour were still found to function well when topped up for Caesarean section. Compared to 'generalists', specialist obstetric anaesthetists might possibly have a lower rate of failed labour epidural conversion because they are more experienced in managing problematic labour epidural analgesia and are more likely to replace a poorly functioning epidural catheter before the need for Caesarean section arises. Several recommendations have been made in order to decrease the risk of failed labour epidural to surgical anaesthesia top-up (Table 2).[3]

Consideration of a labour epidural for conversion to surgical anaesthesia in a Category 1 Caesarean section

Compared to combined spinal–epidural (CSE) and spinal anaesthesia, general anaesthesia is consistently associated with a shorter decision-to-delivery interval in Caesarean section.[5] Labour epidural conversion, however, can facilitate a comparable decision-to-delivery interval to general anaesthesia, with a retrospective audit demonstrating a mean decision-to-delivery interval of 19 and 17 min, respectively, for labour epidural top-up and general anaesthesia.[6] In a recent retrospective cohort study, the operating-room-to-incision interval was shorter for general anaesthesia at 6 min relative to epidural top-up at 11 min, but the longer operating room-to-incision interval did not lead to inferior neonatal outcomes.[5] Use of general anaesthesia, in contrast, has been related to many potential drawbacks for the mother and the neonate.

In the opinion of the authors, labour epidurals that are not working well enough to manage labour pain (e.g. consequent to missed segments or unilateral blockade on objective assessment), cannot be expected to provide adequate surgical anaesthesia for Caesarean section. If a Category 1 Caesarean section is required, a labour epidural that is judged adequate for conversion to surgical anaesthesia should be topped up as soon as practically and safely possible in preference to general anaesthesia. The anaesthetist should continue to evaluate for bilateral and progressively cephalad blockade, yet must be prepared and ready to induce general anaesthesia should the adequate density and level of blockade not be obtained.

Confirmation of the correct location of the labour epidural catheter

Between 1970 and 1998 in the USA, almost one-fifth of maternal deaths associated with obstetric anaesthesia were related to the administration of epidural anaesthesia, many following the administration of bupivacaine 0.75% and the result of inadvertent high or total spinal blockade or LA systemic toxicity (LAST).[7] In view of such severe consequences, it is crucial that the correct location of the epidural catheter is confirmed before the injection of drugs.

Gentle aspiration of the epidural catheter, examining for blood or cerebrospinal fluid (CSF), allows a misplaced epidural catheter to be identified effectively and immediately. Gentle aspiration has been associated with a sensitivity of 98% and a specificity of 100%, but can give rise to false negative findings. In 2003 in the UK, only 34% of respondents with an interest in obstetric anaesthesia administered an epidural test dose for emergency Caesarean section.[8] The epidural test dose can be defined as the administration of a small amount of LA with or without adrenaline in order to determine whether or not the epidural catheter is located in a blood vessel or the subarachnoid space. This practice is an area of continued controversy and many argue that the use of an epidural test dose

Table 2 Recommendations to decrease the risk of failure of converting epidural analgesia for labour to surgical anaesthesia for Caesarean section[3]

In the delivery room before any decision to proceed to Caesarean section
• Early recognition of poorly functioning epidural analgesia, providing the anaesthetist with an opportunity to manipulate or replace the epidural catheter
• If the obstetrician expresses concern about a parturient's slow progress in labour or the fetal heart rate tracing, the anaesthetist must re-evaluate how well the epidural is functioning in anticipation of the need to convert to surgical anaesthesia
In the operating theatre after the decision to proceed to Caesarean section
• Inspection of the epidural catheter to check that it has not migrated since placement in labour
• If sufficient time is available, the function of the epidural can be tested by administering one-quarter to one-third of the full LA dose, examining initially and subsequently every 3–5 min for the bilaterally, level and density of sensory blockade
• In the absence of definite evidence of bilateral and progressively cephalad sensory blockade of adequate density, more than half of the full LA dose should not be administered

is not needed in this setting as the position of the epidural catheter has already been confirmed during labour. Despite this, multicompartmental block, rupture of the arachnoid mater after subdural placement of the epidural catheter and secondary migration of the epidural catheter can all still occur. Multicompartmental block is the misplacement of multi-orifice epidural catheters where a distal opening lies in a blood vessel or the subarachnoid space while a proximal orifice simultaneously retains access to the epidural space. Use of an epidural test dose needs to be balanced against the delay incurred in establishing adequate blockade for Caesarean section to commence.

In a prospective cohort study in parturients, the mean onset of objective block was 1.5 min after the intrathecal injection of 2 ml lidocaine 1.5%, compared with 9 min, with no detectable sensory blockade at 1.5 min, after the epidural injection of 3 ml lidocaine 1.5%.[9] If an epidural test dose consists of a LA with a lengthier onset time, such as levobupivacaine, then the time required to exclude the intrathecal placement of an epidural catheter can be longer than one is willing to wait. Unlike intrathecal 3 ml lidocaine 2%, the spinal administration of 3 ml bupivacaine 0.25–0.5% does not reliably produce motor blockade.[10] The anaesthetist can use clinical judgment to differentiate between the pattern of increases in heart rate induced by adrenaline or pain and enquire about the occurrence of systemic symptoms such as dizziness, metallic taste, palpitations, or tinnitus. If the criterion of an increase in maternal heart rate of 10 beats min^{-1} within 1 min after injection is used in conjunction with clinical evaluation, the epidural administration of adrenaline at a test dose of 10–15 μg with lidocaine in uterine diastole has a sensitivity and specificity of up to 100% and 96%, respectively.[11] However, not all research supports this conclusion, and, in one study, adrenaline as part of an epidural test dose with lidocaine did not compare favourably with the simple aspiration of the epidural catheter. Furthermore, some are concerned about the possibility of adverse effects of adrenaline on the mother and fetus, but studies suggest that i.v. adrenaline at a dose of 10–15 μg is not harmful to the fetus.

In the opinion of the authors, even with an appropriately functioning labour epidural, every epidural top-up dose must be considered a test dose such that with incremental dosing no harm will result, even if the epidural catheter is located in the intrathecal or intravascular space. In this regard, lidocaine 2% with or without adrenaline, fentanyl, or both can be considered advantageous in serving as both the epidural test and top-up dose for Caesarean section. The anaesthetist should administer the epidural top-up and continue to evaluate for bilateral and progressively cephalad blockade over a time interval suitable to the urgency of the Caesarean section.

Location of the labour epidural conversion

The decision of where to best initiate the labour epidural conversion continues to be debated and is influenced by many factors including the local logistics and urgency of Caesarean section. In 2003 in the UK and in 2014 in Scandinavia, 81% and 33% of respondents with an interest in obstetric anaesthesia, respectively, initiated extension of the labour epidural blockade in the delivery room as opposed to the operating theatre.[8,12] It has been argued that administration of an epidural top-up in the delivery room and concurrent urgent transfer to the operating theatre can enable provision of an epidural test dose and decrease the decision-to-delivery interval. Conversely, it has been reasoned that administration of an epidural top-up in the operating theatre can facilitate improved monitoring of the parturient and increased identification of complications such as high or total blockade, hypotension and LAST.

In the opinion of the authors, an individualised risk–benefit decision should be made about the administration of an epidural test dose, appropriate location of epidural conversion and the rate of administration. In our clinical practice, after the negative aspiration of the epidural catheter, we administer an epidural test dose where possible to the parturient in the delivery room as soon as a decision for Caesarean section has been made. This is followed by immediate transfer to the operating theatre for full conversion of labour epidural analgesia to surgical anaesthesia in the presence of safe monitoring and resuscitation facilities, once the effect of the epidural test dose has been evaluated. For a Category 1 Caesarean section, in contrast, a more aggressive strategy of epidural top-up with increased dosing in the delivery room may be suitable. The anaesthetist should stay with the patient at all times once an epidural top-up has been started.

Choice of LAs and adjuncts

Opinions expressed in previous surveys are divided with regard to the optimal epidural top-up solution for Caesarean section.[8,12] In a meta-analysis, lidocaine 2% plus adrenaline (usually added to achieve a concentration of 5 μg ml^{-1} in the resulting mixture), with or without fentanyl, was associated with the fastest onset of surgical blockade, with a mean

difference of 1.7–4.5 min compared with bupivacaine or levobupivacaine 0.5% or ropivacaine 0.75%.[13] The addition of epidural fentanyl at a dose of 50–75 μg further decreased the onset time of surgical blockade by a mean difference of more than 2 min. Ropivacaine 0.75% was related to the lowest need for intraoperative supplementation but the addition of fentanyl, unlike in elective Caesarean section,[14] did not reduce this requirement. It is possible that the fentanyl contained in the epidural solution administered for labour could have already produced a near-maximal effect, explaining the observed difference in the emergency compared with elective Caesarean section. Bupivacaine and levobupivacaine 0.5% were the least effective solutions with respect to speed of onset and quality of block. Mixing of bupivacaine 0.5% and lidocaine 2% in a 1:1 ratio does not seem to confer an advantage over lidocaine 2% alone and adds an extra step to the drug preparation process. However, it is difficult to make a decision about which drugs to use in the epidural top-up solution when we seek both speed of onset and quality of block. Moreover, in terms of the risk of LAST, levobupivacaine and ropivacaine are less cardiotoxic and have a greater margin of safety relative to bupivacaine, which at higher concentrations has been previously related to maternal mortality.[7]

Bicarbonate can facilitate the alkalinisation of the epidural top-up solution, increasing the unionised fraction of lidocaine available to cross the neuronal membrane and possibly increasing the lipid solubility of fentanyl and its penetration into both the spinal cord and systemic circulation. It can be added as 2 ml bicarbonate 8.4% to 20 ml lidocaine with 2 ml of the resulting mixture then discarded, but should not be administered with bupivacaine, levobupivacaine, or ropivacaine as precipitation can occur. Comparison of lidocaine and adrenaline with or without bicarbonate in the epidural top-up solution has shown a mean reduction in onset of 4.5 min when bicarbonate was added.[15] Nevertheless, concerns have been raised about whether the extra drug preparation time may offset some of the time saved and the potential risk of error and safety implications when mixing medications in the emergency situation.[13] With anaesthetists unfamiliar with the preparation of the lidocaine, adrenaline and bicarbonate solutions for epidural use, the preparation time increased four-fold when compared to bupivacaine, yet in those familiar with it, the extra preparation time is less than 1 min.

Evaluation of the adequacy of neuraxial blockade

In view of the lack of standardisation in the assessment of neuraxial blockade for Caesarean section, multiple different sensory modalities have been used by obstetric anaesthetists to test whether the extent of blockade corresponds to particular dermatomal levels.[16] However, it has been demonstrated that the loss of sensation to touch up to and including T5, between the nipple line and the xiphisternum, is the most reliable modality to prevent pain during Caesarean section.[17] Russell advocates that the cephalad dermatomal level to touch should be characterised as the first sensation of light touch.[18] Conversely Yentis recommends that this should be defined as the point at which the sensation of touch no longer changes when the stimulus is applied yet more cranially.[19] Such contrasting definitions add confusion to the interpretation of the dermatomal level of touch for adequate anaesthesia. Given that the afferent nerves carrying sensation of pain from the pelvic organs are thought to accompany the sympathetic nerves and enter the spinal cord around T10 to L1 and that the neuraxial blockade is required to be much higher than T10, other non-conventional nerve pathways must be involved in the transmission of pain in Caesarean section. It could be that some of the pelvic afferent nerves follow the sympathetic nerves through the intra-abdominal plexuses and the greater splanchnic nerve to reach the spinal cord as high as T5. It may be that the visceral pain is not of pelvic origin but originates from other intra-abdominal structures innervated by the afferent nerves which enter the spinal cord at T5.[17] In the absence of neuraxial opioids, testing for loss of sensation to touch was shown to have a sensitivity of 98% and a specificity of 53% in discriminating effective from ineffective neuraxial blockade for Caesarean section.

In 2010 in the UK, more than two-thirds of respondents with an interest in obstetric anaesthesia who evaluated a single modality to test neuraxial blockade used the loss of cold sensation to T4.[16] Cold and sharp pinprick testing have sensitivities of 12% and 55%, respectively, in discriminating effective from ineffective neuraxial blockade. The significance of this is that just 12% of parturients who encounter pain in Caesarean section will have a loss of sensation to cold below T4.[18] If and when assessing modalities other than touch, it is fundamental to ensure adequate anaesthesia, defined as the lack of awareness to the sensation rather than only the absence of cold or sharp pinprick. The loss of sensation to cold or sharp pinprick should not be a substitute or surrogate measure for loss of sensation to touch. In neuraxial blockade, loss of sensation to cold is found to be many dermatomes higher than the level at which sensation to sharp pinprick is lost and this, in turn, is observed to be several dermatomes higher than loss of sensation to touch. Nevertheless, there is not a constant relationship between the dermatomal levels assessed by these three sensory modalities with significant variation within and between individuals. Thus, determining the dermatomal level of blockade to one modality does not facilitate the prediction of the dermatomal level of blockade of any other modality. The caudal dermatomal level of blockade should be assessed for by loss of sensation from the lateral margin of the foot, corresponding to S1, to the anterior leg and thigh, covering the lumbar dermatomes. It is important to block the sacral segments in order to prevent pain during pressure and traction on the lower uterus, cervix and vagina. Motor block of the lower limbs is secondary to blockade of the lumbar segments and can be evaluated with the Bromage scale or straight leg raising.

Clinical management of failed labour epidural analgesia to surgical anaesthesia conversion

If conversion of labour epidural analgesia to Caesarean section anaesthesia fails, the anaesthetist can be confronted with a complex clinical dilemma. Optimal management of a failed labour epidural top-up is subject to continued controversy, particularly in the absence of best practice guidelines.[20] Subsequent anaesthesia management options, including manipulation or replacement of the epidural, performance of a CSE or spinal, or induction of general anaesthesia, all have potential drawbacks and can introduce anaesthetic risk to the parturient and the neonate (Table 3).[3]

Table 3 Drawbacks and risks associated with the various different management options after failed conversion of epidural analgesia for labour to surgical anaesthesia for Caesarean section. CSE, combined spinal–epidural; LAST, LA systemic toxicity; PONV, postoperative nausea and vomiting

Management	Drawbacks and risks
CSE	Longer time to perform Difficult to choose the optimal intrathecal dose of LA Untested epidural catheter if subsequent epidural dosing needed Potential of LAST with epidural administration of additional LA
General anaesthesia	Accidental awareness Complications associated with aspiration and failed intubation Greater maternal and neonatal sedation Increased risk of poor uterine tone and blood loss Related to depressed Apgar scores at 5 min, the need for bag mask ventilation and admission to neonatal intensive care Increased postoperative pain and PONV Impairment of early breast feeding and maternal–neonatal bonding
Manipulation or replacement of epidural	Longer time to perform Potential of LAST with epidural administration of additional LA
Spinal	Difficulty in obtaining cerebrospinal fluid and increased risk of block failure Difficult to select the optimal intrathecal dose of LA Decreases in the intrathecal dose of LA further increase the risk of block failure Potential of high or total spinal with standard or modestly reduced intrathecal dose of LA

If unilateral sensory blockade occurs, the unfavourable location of the epidural catheter, either positioned too lateral in the epidural space or outside the epidural space after passing through the intervertebral foramen, may be corrected by withdrawal. Such withdrawal of the epidural catheter followed by the administration of additional LA in surgical anaesthetic concentrations was identified as an effective intervention in more than four-fifths of cases of failed labour epidural conversion in a retrospective analysis.[21] However, this approach can take a long time to perform, leading to delays, and further administration of LA can increase the risk of LAST.

It can be challenging to perform a spinal in the context of a failed labour epidural conversion because of the associated difficulty in obtaining CSF. This could be attributable to the collapse of the subarachnoid space below the termination of the spinal cord secondary to the volume effect of the epidural bolus. Spinal anaesthesia performed within 30 min of a failed labour epidural top-up has been associated with an increased risk of failure and may reflect the erroneous assumption that the free flow of clear fluid must be CSF rather than previously injected LA within the epidural space. The increased likelihood of high or total spinal blockade related to spinal anaesthesia subsequent to failed labour epidural conversion might be secondary to the pre-existing subclinical analgesia caused by prior exposure of the neuronal tissue to epidural LA solution, compression of the dural sac by residual LA in the epidural space resulting in cephalad displacement of the intrathecally injected drugs and the leakage of LA through the dural hole into the subarachnoid space. Measures recommended to decrease the risk of high and total spinal blockade include performing the spinal in the sitting position, reducing the dose of intrathecal bupivacaine by 20% and delaying supine positioning following the spinal injection.[22] Nevertheless, such a decrease in the dose of intrathecal LA may not be sufficient to prevent high or total spinal blockade and can further increase the likelihood of later intraoperative block failure.

Use of a CSE facilitates the administration of a decreased initial dose of intrathecal LA with a reduced risk of block failure because of the ability to provide additional LA as needed through the epidural catheter. Concerns about the risk of the untested epidural catheter have not been substantiated by the literature, which suggests that the incidence of a failed epidural component is unlikely after a successful CSE.[23] Studies report longer performance times for CSE compared to spinal, but only one trial showed a clinically meaningful difference of 11 min.[24] General anaesthesia has been associated with accidental awareness under anaesthesia and complications related to aspiration and failed intubation, with critical incidents mainly occurring after the failed conversion of neuraxial anaesthesia rather than primary general anaesthesia.[25]

Table 4 Comprehensive components of an obstetric anaesthetic follow-up

- Ask about the presence and control of postpartum pain
- Confirm the appropriate prescription and use of optimal multimodal analgesics and determine her opioid requirements
- Evaluate for adverse effects to include nausea, vomiting and pruritus
- If received general anaesthesia, determine if any awareness or recall is present
- If received neuraxial blockade, exclude the presence of complications: postdural puncture headache; nerve injury (sensory or motor changes in the lumbar or sacral distribution); early epidural abscess (risk factors, back pain and pyrexia); and epidural haematoma (risk factors, back pain, motor impairment, sensory loss and urinary retention)
- Consider affect and mood, evaluating for evidence of symptoms consistent with depression or post-traumatic stress disorder
- Enquire about her ability to drink, eat, mobilise and sleep, and the capacity to care for her neonate
- Elicit her views about the quality of intrapartum, intraoperative and postpartum pain relief provided
- Enquire about her overall level of satisfaction with the anaesthetic care received
- Safety net: educate her about the symptoms of postdural puncture headache, if at risk, and pre-eclampsia; and provide verbal and written information about when and how to seek further advice and help

Follow-up

All women who receive intrapartum anaesthetic care, whether analgesia for labour or anaesthesia for operative procedures, should be followed up routinely in order to determine general well-being, exclude any complications such as epidural haematoma or postdural puncture headache, monitor for adverse effects such as pruritus or vomiting, and obtain comments and feedback on the quality of the analgesia and anaesthesia service (Table 4).[26] Serious complications such as epidural abscess may not manifest clinically until after a woman has been discharged from hospital and it is thus necessary that verbal and written information about when and how to seek further advice and help is provided. Those with identified complications such as postdural puncture headache should be contacted daily and offered postpartum follow-up review as an outpatient with a consultant anaesthetist.

Declaration of interest

The authors declare that they have no conflicts of interest.

MCQs

The associated MCQs (to support CME/CPD activity) will be accessible at www.bjaed.org/cme/home by subscribers to BJA Education.

Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bjae.2019.09.006.

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