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ESSENTIAL NOTES

Identifying a correctly positioned thoracic epidural catheter for major open surgery

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A correctly positioned thoracic epidural catheter is regarded as fundamental for many major open abdominal and thoracic surgical procedures. It can provide superlative segmental analgesia whilst helping to minimise opioid usage and reduce postoperative complications.[1] However, a misplaced epidural catheter can be disastrous, resulting in inadequate postoperative analgesia, and whilst it remains *in situ* the patient may be denied some of the alternative analgesic modalities. In addition, the epidural catheter may need to be re-sited postoperatively, and this may be associated with constraints such as difficulties in positioning the patient and other potential postoperative issues such as coagulopathy.

The failure rate of a thoracic epidural, providing unsatisfactory analgesia, can be as high as 30%.[2] There is no uniform definition of epidural 'failure', which encompasses a spectrum of clinical scenarios including insufficient analgesia, perhaps requiring catheter replacement or conversion to another major treatment modality such as i.v. patient-controlled analgesia, to catheter dislodgement or early discontinuation of epidural analgesia.[2] The aetiology of a failed thoracic epidural is often a misplaced catheter outside of the epidural space.[3] Several other factors may also contribute to apparent epidural 'failure' such as the wrong level of insertion for the proposed surgery or giving an inadequate dose of local anaesthetic via the epidural catheter. In many institutions, there is a decline in the use of thoracic epidural analgesia with the advent of minimally invasive surgery and with increasing use of other forms of analgesia such as abdominal wall nerve blocks. Nevertheless, there is still a need for effective thoracic epidurals.

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Procedural checks to confirm the epidural catheter is positioned correctly

There is a plethora of checks to increase the likelihood of recognising that the epidural catheter is sited in the correct position. The 'loss of resistance' (LOR) to saline technique, as the Tuohy needle advances into the epidural space is used most commonly. LOR to air is also used but the endpoint is more subtle and has been associated with air bubbles visible on imaging adjacent to unblocked nerve roots. Both lack specificity and are prone to variability between anaesthetists.[4] Older methods, such as hanging drop methods and epidural balloons (such as Odom's indicator), are no longer commonly practised. It is a potential pitfall of assuming the epidural space has been located, without using the following additional procedural checks that we find useful.

After removing the Tuohy needle, we recommend holding up a saline-filled epidural catheter to acts a manometer to observe the falling column of liquid within it, known as a 'meniscal drop'. If the epidural catheter had been threaded into a different space, for example subcutaneous fat, then this observation of the 'meniscal drop' would be absent.[5] A further confirmatory procedural check is to ascertain that you are unable to aspirate blood or CSF from the epidural catheter to ensure that it is not positioned in an epidural vein or the intrathecal space respectively.

The length of the catheter that remains in the epidural space is important, but this is a compromise. If there is excessive catheter length in the epidural space, this risks it emerging from one of the intervertebral foramina.[2] Conversely, if there is insufficient catheter length in the epidural space, the proximal hole (i.e. the hole nearest the anaesthetist) of a multiholed epidural catheter many not be located within it. Given that the apertures in a multiholed catheter are typically 8, 12, and 16 mm from the tip, and some movement of the catheter relative to the

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patient is inevitable, our practice is to leave about 5 cm of catheter in the epidural space. A study has shown that leaving 5.2 cm instead of 4.6 cm of catheter in the epidural space resulted in a reduction in catheter dislodgement from 14.5% to 5.7%.[6]

The epidural test dose

The use of an epidural test dose was described in the middle of the past century.[7] This is much more relevant for patients who are conscious and was popularised in obstetric practice. Classically, if not in the epidural space, an epidural catheter is considered to be at risk of being located intrathecally, intravenously, subcutaneously, or more rarely in the subdural space. Adrenaline (epinephrine), typically in a dose of 15 μg, is useful to identify intravascular placement, observing for an increase in arterial blood pressure of 15 mmHg or an increase in heart rate of 10 beats min^{-1}. It is rarely used in the UK, as some fear that spinal cord ischaemia may result, although this is very unlikely to occur and is more likely to result from other factors such as large quantities of epidural injectate (increasing CSF pressure) or systemic hypotension, both of which will impair spinal cord perfusion pressure. The use of fentanyl 100 μg while observing for dizziness or sedation within 5 min has also been described.[7] A small dose of local anaesthetic (such as at least lidocaine 45 mg, or bupivacaine 12.5 mg) has been described to distinguish between epidural and intrathecal placement. This dose in the intrathecal space will cause marked hypotension and sensorimotor block but should have little observable effect if the epidural catheter is sited correctly. However, this is not feasible to assess under general anaesthesia. It is also worth remembering that with the usual multiholed epidural catheter, slowly injected fluids preferentially exit the most proximal hole, whereas during rapid injections approximately equal fluid volumes exit from each hole.[8] This means that further care is required in the interpretation of the test dose. For example in a misplaced catheter, the distal hole may have penetrated the dura, but the two more proximal holes may be sited in the epidural space. For conscious patients the situation is easier, and a convenient test dose is 3 ml lidocaine 2% with 1:200,000 adrenaline (60 mg and 15 μg, respectively) to exclude intrathecal or intravascular catheter placement.

Intraoperative assessment

It is difficult to assess intraoperative analgesia in a patient who is anaesthetised, and it can be challenging to recognise an incorrectly positioned epidural catheter that has been sited just after induction of general anaesthesia. Classically, assessment of evoked sympathetic responses has been used as a surrogate marker for analgesia, such as tachycardia and hypertension. However, concurrent medication (such as beta-blockers) may attenuate these responses even though they have no intrinsic analgesic properties. Moreover, intraoperative analgesic techniques, such as the administration of opioids, can mask these physiological signs, too. Quantifying nociception objectively would represent the gold standard, and although various methods have been described to characterise the nociception *vs* anti-nociception balance, including pupillometry monitoring, the surgical plethysmographic index (SPI), and the analgesia nociception index (ANI), there are few convincing data to support their use to improve outcomes.[9]

Additional modalities that can be used to check the position of the epidural catheter

Epidural catheter position can be confirmed with CT epidurography. This involves injecting contrast down the epidural catheter, and it is similar to the practice of checking the position of the epidural space in the setting of intervention for chronic pain management. However, this technique has not gained popularity within the operating theatre environment because of exposure to ionising radiation in addition to negative effects on the efficiency of the theatre list.

The epidural electrical stimulation test, also known as the 'Tsui test', has gained prominence in certain countries. The scientific basis behind this technique involves an electrical current being applied to the epidural catheter, and a resultant evoked muscle contraction is observed. This is not useful in clinical practice if a local anaesthetic test dose has already been given. However, for patients undergoing abdominal surgery, the Tsui test has a higher sensitivity compared with a local anaesthetic test dose in predicting adequate postoperative epidural analgesia.[10] The widespread use of this modality to confirm epidural catheter position is limited predominantly by the lack of the equipment required.

Epidural waveform analysis involves connecting a pressure transducer via the Tuohy needle or epidural catheter. If the needle or catheter is in the epidural space, a recognisable pulsatile waveform is observed, and this modality could be a useful adjunct to the LOR technique to identify the correct space. It has been shown that this modality conferred a thoracic epidural failure rate of 2% compared with 24% in the group with a conventional LOR technique without epidural waveform analysis.[11] This technique is currently limited by the longer time taken to transduce the pulsatile waveform and the requirement for additional equipment.

Ultrasound is becoming a useful adjunct to visualise the epidural space in other areas including obstetric anaesthesia. Colour Doppler ultrasound has been used to demonstrate the position of epidural catheters and is based on injecting saline down the catheter to generate changes in the ultrasound image. This can demonstrate an incorrectly positioned catheter, for example in the intrathecal space. However, the thoracic spine has notoriously suboptimal sonographic windows, and its role in clinical practice has not developed further at present.[12]

Conclusions

The number of thoracic epidural catheters sited in clinical practice is dwindling in some institutions but very much at the forefront of perioperative analgesic strategies in others. There is still a small risk of the patient emerging from general anaesthesia in significant pain despite the combination of the recommended procedural checks outlined. Currently, we rely on this observational acumen to predict the epidural catheters that will work well to provide good analgesia in the perioperative period for patients having open surgery. There are a growing number of other modalities that are expected to revolutionise current clinical practice in predicting the correct position of thoracic epidural catheters but as yet none are widespread in clinical practice.

Declaration of interests

The authors declare that they have no conflicts of interest.

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