Review Article

The epidural test dose in obstetrics: is it necessary?

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Few topics in anaesthesia have created as much controversy as have test doses for epidural anaesthesia. The term "test dose" refers to the injection of a small amount of local anaesthetic solution in order to reveal either accidental intravenous or subarachnoid injection. Numerous reports have suggested the composition and volume of test doses and numerous letters to the editor question the validity of the studies. At least two reports question the need for a test dose.[1,2] In this review, we discuss the historical basis of the use of test doses, the local anaesthetics used and the use of epinephrine. We also review the controversies surrounding test doses and we make practical suggestions in the context of obstetrical anaesthesia.

What is a test dose?

The ideal test dose should satisfy certain criteria: (1) it should prevent accidental intravenous or subarachnoid injection of the total dose required for regional anaesthesia; (2) it should not significantly delay the onset of epidural anaesthesia; (3) it should not increase the risk of complications.

The test dose, to be practical, should consist of a single solution that within two or three minutes from its injection produces obvious clinical evidence that the solution has been injected into either a blood vessel or the cerebrospinal fluid.

Test for intravenous injection

Accidental intravascular injection of a toxic dose of local anaesthetic may cause one or more of the following signs and symptoms: a relaxed feeling, drowsiness, lightheadedness, tinnitus, circumoral paraesthesia, metallic taste in the mouth, slurred speech, blurring of vision, unconsciousness, convulsions, cardiac dysrhythmias and cardiac arrest.

Intravenous injection of epinephrine causes palpitations, nervousness, circumoral pallor, increased heart rate, dysrhythmias, and an increased systolic blood pressure. The use of a small dose of epinephrine, 15 μg, has been advocated in the hope that the signs of intravenous injection will be observed and injection of toxic doses of local anaesthetics would be avoided.

Moore and Batra[3] were the first to study the use of epinephrine in a test dose to prevent accidental massive intravenous injection. They studied 175 adults who received local anaesthetics with epinephrine intravenously. The anaesthetics included 3 ml of either 0.75 per cent bupivacaine, 1.5 per cent mepivacaine, 1.5 per cent lidocaine, or 3 per cent 2-chloroprocaine with 15 μg of epinephrine. Each patient's electrocardiogram was monitored continuously. Patients were given diazepam 10–15 mg and fentanyl 100 μg intravenously on arrival in the operating room. Three millilitres of one of the above test-dose solutions were administered to each patient into a peripheral vein prior to the insertion of the epidural needle.

The heart rates of the 175 patients increased from a mean of 79 ± 14 to 111 ± 15 beats·min^{-1}. The heart rate increased within 23 ± 6 seconds after injection and returned to the control rate within 32 ± 33 seconds. Similar results were obtained in ten unpremedicated volunteers.

Moore and Batra concluded "that for a single test dose of a local anesthetic solution to be of value in signalling in all patients the possibility of an intravascular or subarachnoid injection while performing epidural block it must contain 0.015 mg of epinephrine and a milligram dose of the local anesthetic drug which rapidly results in evidence of spinal anaesthesia."

There are several problems inherent in their study. The

Key words

ANAESTHESIA REGIONAL: epidural, lumbar; ANAESTHETICS, LOCAL: lidocaine, test dose; TOXICITY: local anaesthetics; ANAESTHESIA: obstetrical

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subjects were elective surgical patients of unstated age and sex. They were premedicated prior to epidural blockade, to the point where they had to be aroused to elicit a verbal response to the test dose. As well, local anaesthetics and the concentrations that they studied are not generally used in the obstetrical patient in labour. This study lacked a control group and the sensitivity and specificity of this diagnostic test was not stated. Therefore, it is possible that their data are not applicable to the pregnant woman in painful labour.

Two recent studies have questioned the validity of using a test dose containing epinephrine to detect an intravascular injection. It is clear that measuring the heart rate response in unpremedicated women in labour is fraught with potential for misinterpretation.

False positive intravenous test doses

Cartwright *et al.*[4] studied 100 healthy women in active labour. Each had an epidural catheter placed at the L_2-L_3 interspace and was given a test dose of 3 ml of 0.5 per cent bupivacaine without epinephrine into the epidural space. There was no evidence of intrathecal injection in any of the patients. However, the maximum heart rate increased by more than 20 beats·min^{-1} in 24 women and by more than 30 beats·min^{-1} in 12 women in the following 60 seconds and, in fact, none of these catheters were intravascular.

It is widely accepted that when test doses containing 15 μg of epinephrine are injected intravenously, a positive test dose is present when the heart rate increases by greater than 30 beats·min^{-1} within 25 seconds of injection. If this definition is true, *there would be a false positive test in 12 per cent of the patients studied by Cartwright et al.* This implies that in 12 per cent obstetrical patients, the catheter would be removed unnecessarily. Previously, it had been reported that the incidence of accidental intravenous placement is between 0.01 and 4 per cent.[5–7] False positive test doses may also be related to the timing of the injection relative to uterine contraction. Test doses should probably be given between uterine contractions since contractions are often associated with increased maternal heart rate.

False negative intravenous test doses

Leighton *et al.*[8] observed 20 unanaesthetised, healthy, term parturients in active labour with no evidence of fetal distress, and continuously recorded maternal and fetal heart rate and uterine contractions. In ten patients, 3 ml of normal saline were injected and in the other ten patients, 3 ml of normal saline containing 15 μg of epinephrine were injected into a peripheral vein.

If analysed based on Moore and Batra's criteria, an increase of heart rate of greater than 25 beats per minute lasting greater than 15 seconds, 2/10 of the normal saline group and only 5/10 of the epinephrine group would have been identified as having a positive test dose. This gives a sensitivity of 50 per cent. Two of the fetuses in the epinephrine group and none in the normal saline group had an episode of fetal distress lasting 10–12 minutes, although this was not statistically significant.

It may be concluded from these two reports that an epidural test dose containing 15 μg of epinephrine to rule out accidental intravenous administration is neither sensitive nor specific in the obstetrical patient in active labour. Erroneous diagnosis of intravenous injection occurs in 12 to 20 per cent of these patients.[4,8] The 50 per cent occurrence of a false negative intravenous test[8] is potentially dangerous, as it may give the anaesthetist the impression that the epidural catheter is not placed in a vein. In addition, the effects of intravenous epinephrine on the human fetus have yet to be thoroughly assessed.

Can intravenous epinephrine cause harm to the fetus?

Epinephrine-containing solutions have been shown to decrease uterine blood flow in gravid chronically instrumented ewes.[9] Epinephrine 5, 10, or 20 μg were injected intravenously as were solutions of bupivacaine 5 mg with and without 10 μg of epinephrine. There were no significant changes in fetal or maternal blood pressures or blood gases. Epinephrine did however cause statistically significant decreases in uterine blood flow, 20 μg reducing uterine blood flow to approximately 60 per cent of control. When the effect of intravenous epinephrine on uterine artery blood flow velocity was assessed in pregnant guinea pigs, a similar reduction in uterine artery blood flow velocity was observed.[10]

These animal studies quoted suggest that a dose equivalent to a human dose of 15 μg of epinephrine results in a significant decrease in uterine artery blood flow in both sheep and guinea pigs. This does not necessarily mean that the same effect occurs in humans, but this concern exists. It is not clear whether the accidental intravenous injection of 15 μg of epinephrine has potentially harmful effects in humans particularly in pregnancies in which placental blood flow is already compromised, as in patients with intrauterine growth retardation, placenta previa or toxaemia. Epinephrine, in clinical doses in regional anaesthesia, has little effect on placental blood flow in healthy parturients when injected into the epidural space[11] and may be safely used in healthy parturients after an unevenful test dose.

Test for subarachnoid injection

The first reference in the English literature to epidural anaesthesia also refers to the use of a spinal test dose.[12] It has been recommended that the spinal test dose should be

a trial amount of a local anaesthetic followed by a waiting period of five minutes to ensure that the injection has not been made into the subarachnoid space.[13]

Lidocaine has a long history of use as both a local anaesthetic (including spinal and epidural anaesthesia) and as an antiarrhythmic.[14] The efficacy of lidocaine as an epidural test dose has recently been described.[15] Spinal anaesthesia was administered to 15 patients for obstetric procedures using 2 ml of 1.5 per cent lidocaine in 7.5 per cent dextrose. The patient was placed in the left lateral decubitus position with the head of the bed elevated ten degrees. The time to onset of the block at the S_2 dermatome (posterior aspect of thigh from popliteal fossa to the buttock) was noted to be 1.45 ± 0.12 minutes. All patients developed objective sensory block by two minutes following injection (Figure). The average cephalad spread of the block was T_9 ± 1.

Lidocaine 1.5 per cent in 7.5 per cent dextrose with 15 μg of epinephrine, either 2 or 3 ml, were inserted through a catheter at the L_{2-3} or L_{3-4} interspace in 250 women requesting epidural analgesia. At the time of the test-dose injection, the head of the bed was elevated 10 degrees and the patients were in either the left lateral decubitus position or supine with 15 degrees of left uterine tilt. The time to objective sensory loss to pinprick was recorded at the S_2 dermatome. Two hundred and thirty-two patients developed an objective sensory block in 20 minutes with a mean onset time of 8.92 ± 0.22 minutes and only one patient demonstrated a block within four minutes. Eighteen patients had no sensory block after 20 minutes, presumed, by the authors, to be due to an intravascular injection.

One commonly used solution for a test dose is isobaric bupivacaine 0.5 per cent with 1:200,000 epinephrine. Isobaric bupivacaine is unsatisfactory because of the variability in the level of the subarachnoid block achieved and the highly variable onset of action as a spinal anaesthetic agent.[16–19]

Is the use of a test dose safe in obstetrics?

The limitations of test doses are evident from the discussion above. Despite this, a test dose is considered mandatory.[20] There have been no controlled studies comparing the incidence of complications of epidural anaesthesia with and without a test dose.

Some would say that use of a test dose makes the insertion of a catheter obligatory. Epidural catheter insertion *may decrease* the safety of epidurals in obstetrical anaesthesia because of the well known complications of epidural catheters: kinking, knotting,[21] blood vessel puncture[22] and migration.[7] Theoretically, there may be an increased risk of spinal root damage with the use of catheters.[23] The use of a catheter increases the incidence

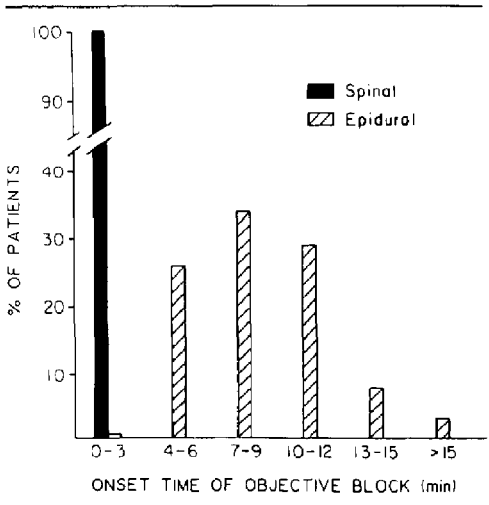

FIGURE Onset of sensory block (to pinprick) following epidural and spinal anaesthesia with 1.5% lidocaine in 7.5% dextrose. (Reproduced with permission from Abraham R.A., Harris A.P., Maxwell L.G., Kaplow S. The efficacy of 1.5% lidocaine with 7.5% dextrose and epinephrine as an epidural test dose for obstetrics. Anesthesiology, 1986; 64: 116–9.)

of blood vessel puncture as compared to a single shot epidural, as more of the epidural space is traversed by the catheter.[23]

"Single shot" versus continuous epidurals

"Single shot" epidurals using lidocaine without a preceding test dose have been shown to be safe when performed in a location with adequate resuscitation equipment available. Eisen *et al.*[24] in 1960 described their experience with 9,532 single shot epidural anaesthetics in women in labour. In two patients, the dura was accidentally punctured and the epidural was performed at another interspace which resulted in total spinals. In two other patients, total spinals occurred when dural puncture was not suspected, for an incidence of 0.042 per cent. Convulsions from intravascular injection occurred six times for an incidence of 0.063 per cent. There were no permanent adverse effects observed in mother or infants in this study. A follow-up series of 26,127 patients from the same institution, quoted the same incidence of total spinals and convulsions.[25] This would suggest that a single shot epidural can be safely used when indicated.

The incidence of complications in this series, without a preceding test dose, is similar to the incidence of complications when a test dose is performed.[1,26] Further work is needed to prove that the use of a test dose through an epidural catheter is a safer technique than the single

shot method. Until that time, the single shot technique should not be considered less safe.

Migration of an epidural catheter into the subarachnoid space is a rare but potentially life-threatening complication of continuous epidural anaesthesia in labour. The incidence of this occurring has been reported as 1:4000[27] and 1:9300.[6] Gentle aspiration and injection of a test dose should be performed before each "top-up." The person injecting the test dose should be capable of recognizing the signs and symptoms of toxicity and trained in cardiopulmonary resuscitation.

Delay in onset of analgesia with a test dose

Test doses delay the onset of analgesia, which some anaesthetists find unacceptable.[28] Others[29,30] say that a few minutes of discomfort is a small price to pay for added safety, although no references are given to prove that extra safety.

Use of a test dose in continuous epidural anaesthesia

Adequate resuscitation equipment and drugs must be immediately available and in good working order prior to initiating the block (Table). After the insertion of the epidural needle, the anaesthetist should check for the absence of blood or CSF prior to placing the epidural catheter. We suggest insertion of the catheter before the injection of any fluid into the epidural space. If one aspirates fluid subsequently, it is from the patient and not the local anaesthetic solution. Insertion of the epidural catheter prior to the injection of any fluid results in an acceptable incidence of paraesthesia and return of blood in the catheter.[31]

The epidural catheter should be inserted a minimum of three centimetres which ensures that the proximal side hole of the catheter lies in the epidural space.[32] A longer length of catheter inserted in the epidural space increases the risk of perforating a blood vessel and of kinking and knotting and extrusion of the catheter through an intervertebral foramen.[32]

Before each administration of local anaesthetic, a test dose should be given through the catheter, and then over the next three minutes, the signs and symptoms of intravenous or subarachnoid block should be elicited. The ideal test dose in obstetrical anaesthesia has yet to be defined. One study using 2 or 3 ml of lidocaine 1.5 per cent in 7.5 per cent dextrose with 15 micrograms of epinephrine has demonstrated that it is relatively easy to rapidly distinguish the difference between subarachnoid and epidural injection.[15] This is superior to the use of isobaric bupivacaine with epinephrine.

The use of lidocaine 1.5 per cent in 7.5 per cent dextrose without epinephrine, 2 or 3 ml, may be the ideal spinal test dose. However, the manufacturers have not yet responded to our needs for such a product in Canada. In the interval, we believe that lidocaine 1–2 per cent, 30–50 milligrams, is the test dose of choice. Lidocaine five per cent in dextrose ten per cent, 50 mg, may be a suitable alternative, but further clinical studies are necessary before we can advocate its routine use.

TABLE Suggestions for administering continuous epidural anaesthesia to parturients in active labour

1 Adequate resuscitation equipment: oxygen, laryngoscope, endotracheal tubes, suction and drugs are to be immediately available in each room where epidurals and "top-ups" are performed
2 Insert the needle, check for the absence of blood or CSF before placing the catheter.
3 Aspirate the catheter gently to check for the absence of blood or CSF.
4 Give the test dose through the catheter, and wait at least two minutes with careful observation for prodromal signs and symptoms of local anaesthetic toxicity and subarachnoid block (sensory block S_2 dermatome).
5 Fractionate the total dose of the local anaesthetic to be used into 5 ml aliquots.
6 Each subsequent "top-up" to be preceded by an appropriate test dose and fractionated as was the original dose.
7 If no block is in evidence within 20 minutes of the last dose, suspect misplacement of the catheter.

The total dose of local anaesthetic to be used, whether for labour or Caesarean delivery, should be fractionated into small volumes. Five millilitre increments of the local anaesthetic should be given over a five-second period. Then, in the absence of symptoms, the total dose should be injected in 5 ml aliquots at 30-second intervals. Thus, each fraction acts as its own intravenous test dose and evidence of systemic toxicity should appear before the total dose has been injected.[20,33]

If no block is evident within 20 minutes, misplacement of the catheter, or intravascular injection should be suspected.[32,34] The anaesthetist should assess this situation immediately.

Summary

One must distinguish between what is medically safe and what is legally safe. The authors have the impression that in order to be "legally safe" one must perform a test dose. This is despite the fact that it has not been conclusively shown that the use of test doses improve the safety margin of epidural anaesthesia, when administered by a competent person, with the proper resuscitative equipment immediately available. Until a controlled study is performed, test doses should be done for continuous epidural anaesthesia with the understanding that they are neither 100 per cent sensitive nor specific in preventing complications. It is however one more manoeuvre that may be useful in recognizing some of the patients with accidental subarachnoid placement of epidural catheters.

The literature suggests that lidocaine 1.5 per cent in dextrose 7.5 per cent should be the test dose of choice in obstetric epidural anaesthesia in an amount known to produce spinal anaesthesia (30–50 mg). The use of epinephrine in test doses in unpremedicated healthy women in active labour is neither sensitive nor specific in signalling intravascular injection, and it may also be detrimental to fetal wellbeing. Epinephrine 15 μg as a test dose for intravenous injection appears to create more problems than it solves.

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