Accidental i.v. injection of local anaesthetics: an avoidable event?

In this issue of the British Journal of Anaesthesia, Abouleish and colleagues report a case in which accidental injection of ropivacaine into an extradural vein resulted in central nervous system toxicity and a seizure. The extradural catheter was inserted while the patient was in labour, but she delivered before it was used. She was then to undergo tubal ligation. In spite of a negative aspiration test and fractionating the total dose of ropivacaine 120 mg over 11 min, the patient had a tonic-clonic seizure. Fortunately, there were no life-threatening cardiac arrhythmias, the ECG indicating only a mild sinus tachycardia, and she came to no harm. The catheter tip was found to contain blood when it was removed. This is one of the first case reports of systemic toxicity with the clinical use of this recently introduced local anaesthetic agent and it raises several issues.

Is a negative aspiration test, particularly when done several hours after the extradural catheter has been placed, reassuring? The catheter had presumably entered an extradural vein, but the blood in the tip of it had clotted. This is the most likely reason for the negative aspiration test. Perhaps an initial flush of the catheter with saline followed by aspiration would have revealed the problem in this case, although it is interesting that a second aspiration test (always a wise precaution after the initial injection), done after the third bolus of ropivacaine, was negative. This suggests that the clot in the tip of the catheter was causing a flap valve effect, allowing injection of local anaesthetic into a vein, but preventing aspiration of blood.

Should an extradural catheter that has been inserted several hours before be “re-used” to establish a block? The answer is probably a guarded yes, but adequate tests must be used to determine if the catheter is within a vessel or has pierced the dura before the therapeutic dose of local anaesthetic is injected. What constitutes an “adequate” test to exclude catheter misplacement? The authors of the report used a test dose of ropivacaine 15 mg followed by a further 22.5 mg, 3 min later, but unfortunately this failed to warn that the catheter was within an extradural vessel.

Is a test dose of 2 ml of ropivacaine 0.75% (to exclude accidental subarachnoid block) followed 3 min later by a further 3 ml of the same solution likely to detect intravascular injection? The answer is probably not. Test doses of ropivacaine 22.5 mg failed to detect intravascular injection in two patients reported in a series by Morton and colleagues; they stated that such a test dose is unsuitable in later correspondence on the issue. The way in which the test dose is injected and the design of the extradural catheter may also influence the chances of a test dose giving a true positive result. The catheter used in this patient had two side holes and a closed end. These openings are usually about 1 cm apart, allowing the distal one to be misplaced and the proximal one correctly sited within the extradural space. A low-pressure, slow injection technique through such a catheter results in most of the injectate escaping through the proximal hole, whereas a high-pressure, rapid injection causes the majority of it to escape via the distal hole. It seems logical, therefore, to inject extradural test doses rapidly under pressure when using multi-holed catheters. The reader should re-visit Bruce Scott’s editorial on extradural test doses, which is as relevant today as it was when published 10 years ago.

Ropivacaine has been shown to be less neuro- and cardiotoxic than bupivacaine in animal and human volunteer studies and this is one of its major advantages. The early symptoms of central nervous system toxicity occur before the cardiovascular effects and tend to be seen at a 25% greater dose of ropivacaine than bupivacaine. However, this may result in a false sense of security when using a test dose of ropivacaine to detect intravascular injection, as exemplified by this case report. Unfortunately, accidental i.v. injection of local anaesthetic agents will occur from time to time even in experienced hands and despite all previous checks. Therefore ropivacaine, which has a higher threshold for causing life-threatening toxicity, is attractive, especially because resuscitation from such a catastrophe is more likely than with bupivacaine. The key question is, how do we reliably detect i.v. injections of local anaesthetics before administering a dose that can cause systemic toxicity? In other words is there a state-of-the-art test dose? Ropivacaine toxicity may be less life-threatening than that of bupivacaine, but it is still better to prevent than treat it.

Extradural test doses have long been a contentious issue among anaesthetists and a variety of techniques (including the addition of epinephrine to the local anaesthetic, rapid injection of 5 ml of bupivacaine 0.5% and use of lidocaine 1 mg kg$^{-1}$ have been advocated. It is interesting to note that a test dose was used in most reported cases of high/total spinal anaesthesia, or serious systemic toxicity, during attempted extradural block. Use of epinephrine with ECG monitoring may be an indicator of i.v. injection but is not without risks, particularly in a patient with ischaemic heart disease or a pre-eclamptic woman in labour. Furthermore, Leighton and colleagues found a 50% false-negative rate when epinephrine 15 μg was injected into a peripheral vein in labouring women. Rapid injection of bupivacaine 25 mg may fail to cause reliable signs and symptoms if injected i.v. in some individuals and, as Scott demonstrated on human volunteers, greater doses of ropivacaine than bupivacaine are required to cause central nervous system toxic effects. Lidocaine is attractive for test dose use because it has a lower toxicity profile than bupivacaine, as quantified by the ratio of both the dose required to cause irreversible cardiovascular collapse and that required to produce convulsions. The ratio is 7:1 for lidocaine and 3:7 for bupivacaine. A lidocaine 1 mg kg$^{-1}$ i.v. test dose was shown to result in central nervous system symptoms in 19 out of 20 patients within 3 min and such a dose administered intrathecially will not result in a particularly extensive spinal block.
Dresner and colleagues\textsuperscript{14} suggested using bupivacaine 10 mg initially as a test for accidental intrathecal catheter placement followed, a few minutes later, by a lidocaine 1 mg kg\textsuperscript{-1} test dose to detect accidental i.v. injection. However, this slightly cumbersome technique may be flawed as well. Prince and colleagues compared the effects of plain bupivacaine 8 mg given extradurally and intrathecally in labour and could only reliably discriminate between the routes after 10 min.\textsuperscript{15}

Perhaps the most important reason that the patient reported in this issue did not have any serious sequelae after the i.v. injection of the extradural dose was because the total dose was given slowly over 11 min. It is important to emphasize that, even after negative test doses or aspiration tests, large doses of any local anaesthetic agent given by any route must be given slowly in divided doses to prevent a catastrophic event. In addition, because of the unpredictability of these events, an argument can be made for routinely using the least toxic local anaesthetic drugs available, such as lidocaine for short procedures and ropivacaine for longer operations, to reduce the risks of inadvertent i.v. administration. There is no doubt that lidocaine is a more forgiving drug than either ropivacaine or bupivacaine when an accidental i.v. injection does occur.

\textbf{Matthew R. Checketts}

\textbf{J. A. W. Wildsmith}

\textit{University of Dundee, Ninewells Hospital and Medical School, Dundee DD1 9SY}

\textbf{References}


