Suitability of the Lumbar Test Dose for the Thoracic Epidural Space

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MOST PERCUTANEOUS approaches to the thoracic epidural space involve blind needle puncture guided by anatomic landmarks. Even for those familiar with these techniques, complications occur including intravascular and intrathecal injection due to catheter misplacement.

Catheter aspiration and the "test dose" are commonly used to identify catheter misplacement and avoid complications. When aspiration fails, injected epinephrine is a useful way to detect an intravascular catheter, and the optimal intravenous dose to safely elicit a response is well characterized.[1,2] Similarly, exaggerated block from local anesthetic injection can identify intrathecal misplacement. The optimal dose to safely elicit this response is well characterized for lumbar injection thanks to spinal anesthesia, but no similar data exist for thoracic injection.

A case is described in which high spinal block and cardiovascular collapse resulted from inadvertent subarachnoid injection of a test dose during placement of a thoracic epidural catheter. A review of the literature, including the limited published data on the consequences of thoracic intrathecal injection of local anesthetic from case reports, retrospective studies, and closed-claim analyses are presented,[3-6] and issues related to the design of the standard thoracic epidural test dose are discussed. The thesis examined is that currently used thoracic local anesthetic test doses are not evidence based, possibly even being primarily guided by their lumbar cousin; furthermore, the evidence that exists indicates that the range of currently used thoracic local anesthetic test doses may be excessively high, posing a risk resembling the complication they are designed to avert, namely high spinal block with cardiovascular collapse.

CASE REPORT

An 87-year-old woman (weight, 50 kg; height, 165 cm), American Society of Anesthesiologists class III, with a medical history including hypertension, atrial fibrillation, and a pacemaker placed for high-grade atrioventricular conduction block, was scheduled for thoracoscopic resection of a right lower-lobe pulmonary nodule. Medical therapy included benazepril, amlodipine, propafenone, and digoxin. Also, the patient had been taking coumadin that was discontinued 6 days before surgery; preoperatively, standard coagulation tests were in the normal range.

On the morning of surgery, routine monitors were applied; vital signs were normal. Oxygen, 2 L/min, was administered by nasal prongs, 1 mg of midazolam was given intravenously, and a right radial arterial catheter was placed. Then, with the patient in the sitting position, using a paramedian approach and a hanging drop technique, 3 attempts at epidural catheter placement at the T6-T7 level were unsuccessful. A single attempt at the T5-T6 level was successful, enabling a catheter to be passed 4 cm beyond the tip of the epidural needle. After a negative aspiration test for blood and cerebrospinal fluid (CSF), a test dose of 3 mL of 1.5% lidocaine (45 mg) with epinephrine 1:200,000 was given. Within 2 minutes of the test-dose administration, the patient complained of dizziness, respiratory difficulty, and weakness in her legs and arms, and her blood pressure dropped from 170/100 mmHg to 70/30 mmHg. The patient's legs were elevated, and 1,000 mL Ringer's lactate and 100-μg increments of phenylephrine were administered to maintain a systolic blood pressure above 100 mmHg (total of 1,000 μg). Although blood pressure dropped, the heart rate remained steady at 70 beats/min (paced). After approximately 30 minutes, the patient's hemodynamic status stabilized, and, although the patient could not move her legs or arms, she was conscious and cooperative without obvious respiratory distress. At this time, aspiration through the epidural catheter was positive for clear fluid, which glucose analysis (42 mg/dL) confirmed to be CSF. When sensory and motor function had partially returned, it was decided to proceed with the scheduled surgery. General anesthesia was induced, tracheal intubation and lung isolation were achieved, mechanical ventilation started, and vital parameters remained stable without inotropic or vasopressor support. The procedure was uneventful, and the epidural catheter was removed after the patient awakened. Neurologic examination was normal. The patient did not develop a postdural puncture headache and had an otherwise uneventful recovery and was discharged on the second postoperative day.

DISCUSSION

A case of high spinal block with hemodynamic collapse after a standard thoracic test dose is described. Sensory and motor impairments and profound sympathetic block occurred immediately after injection of the test dose. Had it not been for the patient's pacemaker, the resuscitative interventions required may have been greater, and, therefore, the authors believe this case warrants a review of the rationale and safety of the thoracic epidural test dose.

The rate of accidental dural puncture for epidural procedures overall is between 0.61% and 10.9%[8]; however, catheter misplacement in the subarachnoid space is less common (0.26% and 0.6%).[8] Thoracic dural punctures complicate 0.6% to 2.5% of epidural attempts,[9] with fewer in the upper than the lower thoracic region (T3-T7, 0.4%; T7-T9, 0.9%; and T9-T12, 3.4%).[6] The rate of unrecognized intrathecal catheter placement in the thoracic region has not been reported. Because dural puncture with a large needle is often heralded by the immediate appearance of CSF, inadvertent intrathecal injection through the needle is rare. However, catheter misplacement is more difficult to detect, and inadvertent intrathecal injection can occur. Moreover, subarachnoid catheter migration may occur hours or days after correct placement.[7] Although aspiration is useful, the absence of CSF does not guarantee that a catheter is not in the subarachnoid space. Hence, the local anesthetic test dose is designed to safely identify malposition and avoid complications subsequent to injection of a much larger dose.

Although some dispute its usefulness, most agree that the test dose is valuable and should be performed.[8,10,11] The American Society of Anesthesiologists closed-claim project is helpful in

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Table 1. Published Reports of High/Total† Spinal Block and Hemodynamic Collapse Because of Thoracic Intrathecal Local Anesthetic Injection

Drug	Known or Suspected* Dose	Route	Interspace/ Nerve Blocks	Duration of Assisted Ventilation†	Reference
Lidocaine	45 mg	IT catheter	T5-T6	Not required	Case
	50 mg	PVB	C5-C6	52 min	27
	60 mg	IT catheter	T10-T11	25 h	14
Bupivacaine	12.5 mg	IT catheter	T8-T9	35 min	20
	15 mg	ICB	—	1 h 30 min	28
	16.7 mg	ICB	T4-T6	6 h	29
	17.5 mg	ICB	—	4 h	30
	22.5 mg	ICB	—	>4 h	31
	25 mg	PVB catheter	T4-T7	2 h	32
	30.35 mg	ICB	—	9 h	33
	40 mg	ICB	T6-T8	4 h 25 min	34
Etidocaine	50 mg	ICB	T3-T7	Not required	35

Abbreviations: IT, intrathecal; PVB, paravertebral block; ICB, intercostal block.

*An assumption is made in cases in which several regional blocks were performed that only 1 block dose of local anesthetic was injected into the subarachnoid space.

†Patients who did not require assisted ventilation did not have block of phrenic nerves and therefore would be considered high spinal as opposed to total spinal block.

understanding the potentially lethal complications of total spinal block.[12] A regional anesthesia analysis reported 21 cases of neuraxial cardiac arrest involving lumbar or thoracic epidurals, and 11 of these involved unintentional subarachnoid block; the outcome in 90% of these cases was death or permanent brain damage.[5] A second chronic pain analysis reported 5 unintentional subarachnoid blocks that resulted in death or brain damage. In 1 case, thoracic injection of 6 mL of local anesthetic resulted in hemodynamic collapse.[13] Unfortunately, none of these analyses describe doses[5,13]; however, the present case is one of several in which cardiovascular collapse has resulted from the thoracic test dose specifically aimed at avoiding this complication.[14] The lumbar test dose has been tailored to achieve a significant block but avoid cardiovascular collapse through the broad experience of clinicians administering spinal anesthesia; equivalent experience does not exist to define the ideal thoracic test dose.

Little exists in terms of published rationale to guide the design of the thoracic local anesthetic test dose. Published surveys indicate that most practitioners use a thoracic test dose but do not detail agents and doses.[15-17] Lidocaine, 60 mg, has been proposed.[11] However, one published report of intrathecal administration of this test dose resulted in total spinal block with hemodynamic collapse requiring the patient to remain intubated and in the intensive care unit for 25 hours.[14] Lidocaine, 45 mg, is prevalent for both the lumbar and thoracic test doses; however, this case shows the potential for high spinal block and hemodynamic instability even with this dose. The safety of lidocaine, 45 mg, has even been questioned for the lumbar test dose in some patient groups (eg, parturients).[3,18,19] Another report describes total spinal, hypotension, loss of consciousness, and need for assisted ventilation for 35 minutes after a thoracic test dose of 12.5 mg of bupivicaine.[20] Curiously, cases describing the effects of thoracic intrathecal local anesthetic injection are more plentiful in reports of regional anesthesia complications (eg, intercostal and paravertebral block, Table 1). Finally, the practice of equivalent dosing of thoracic and lumbar test doses is prevalent but has no formal rationale. On the contrary, although not assessed for subarachnoid injection, equivalent local anesthetic requirements per segment for thoracic epidural catheters are approximately 30% less than for the lumbar space.[21,22]

A brief unstructured review of the recent literature reveals a wide variety of thoracic local anesthetic test-dose regimens in use that resemble local anesthetic doses used for spinal anesthetics (Table 2); these include many doses that would be expected to have far more effect and potential for complications than the lidocaine test dose described earlier. Unfortunately, no published discussion of the rationale for most of these regimens could be found nor reports of the consequences of their thoracic subarachnoid injection.

This reported patient developed high spinal block and hemodynamic collapse after administration of a 45-mg lidocaine thoracic test dose, a dose routinely used in many centers in the United States for both lumbar and thoracic test doses.[23-25] Unique to this case, cardiovascular collapse occurred without bradycardia because of the patient's pacemaker. In accordance with others, this case raises concern that this local anesthetic dose is inappropriately large to test for thoracic intrathecal catheter misplacement for some patients. Specific evaluation of the suitability of the agents and doses originally described for the lumbar test dose has not been performed for the thoracic

Table 2. A Wide Range of Published Thoracic Test-Dose Regimens Are Currently in Use

Drug	Dose Range	References
Lidocaine	40-100 mg	36, 37
Bupivacaine	7.5-15 mg	38, 39
Mepivacaine	20-60 mg	40, 41
Ropivacaine	7.5-20 mg	42, 43
Levobupivacaine	15 mg	44
No test dose		15